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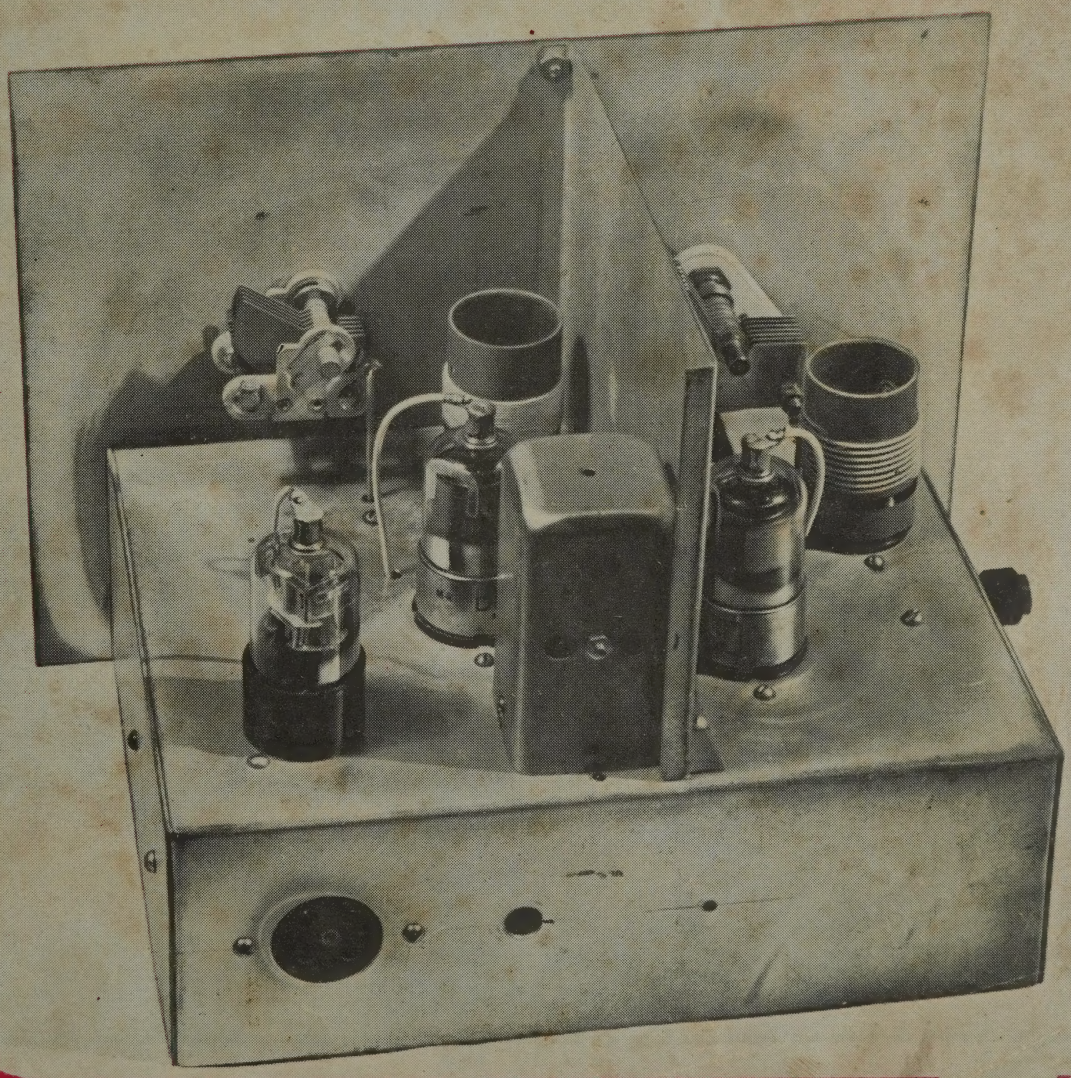

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Vol. 2, No. 8 November 1st, 1947

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OUR COVER

THIS MONTH we feature a view of the Beginners' Superhet, whose description is commenced on page 41 of this issue. It uses the same chassis and valves as the previously described "Progressive Three," and has been designed to demonstrate to learners the fundamental properties of the superheterodyne.

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GUY E. MILNE
ELECTRONIC TECHNICIAN

V.H.F. AND PULSE MODULATION

It has always been our policy, as most readers are probably aware, to publish as much that is new and interesting as we possibly can.

To that end we have lately been carrying out experiments in connection with equipment suitable for the 420-450 mc/sec. amateur band. These experiments have been quite encouraging so far, and we hope before long to publish descriptions of some receiving and transmitting circuits that are quite easy to operate, and that do not require the use of a lathe or other machine shop tools to make them.

Of course, not everyone will be able to use this band with fixed equipment on account of geographical difficulties, but even for mobile work the V.H.F. bands (and particularly this one) should hold a great deal of interest for those who are keen to try something that is outside the usual run of amateur equipment.

For instance, great expense is not a feature of V.H.F. equipment, since "flea-power" only is sufficient for all practical purposes. A small fraction of a watt on these frequencies will be found quite satisfactory, so that the difficulties inherent in producing several watts at V.H.F. disappear entirely.

Still further reducing the power requirement is the fact that the dimensions of a half-wave dipole on this band lie between 33.3 and 36 centimetres, while a quarter-wave rod measures only half these figures. It is therefore possible to build high-gain arrays for the 420 mc/sec. band such as would be quite impracticable for amateurs at any of the lower frequency bands. Alternatively, the short wavelength enables high-gain aerial systems to be constructed very simply, using principles which are quite out of the question at lower frequencies.

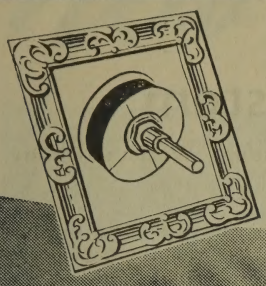
Thus for the man who is suitably situated within line of sight, or nearly so, of some of his amateur friends, this band seems ideal for local "nattering" without causing interference to those who are trying to work more remote stations on the lower frequencies. And for the born aerial experimenter it is the last word. With a 450 mc/sec. oscillator it is possible to scale down any desired low frequency arrangement, and try it out by drawing actual working polar diagrams, without the trouble and expense of experimenting with a full scale job.

This band also opens up other interesting possibilities. A war-time development with which many amateurs are familiar is pulse modulation. This can hardly be applied in any of the lower frequency bands, because of the great bandwidth required to accommodate a pulse-modulated signal, but the 420-450 mc/sec. is wide enough to take a number of such channels side by side. Since propagation on such high frequencies is purely local, except under rare conditions, there is no possibility of pulse modulated transmitters on this band causing interference to others. In addition, the high directivity that can be obtained helps to allow even more channels to be used on this band than could be handled by any other.

With an eye to some new and entertaining work in the field of pulse modulation on the V.H.F. amateur bands, we have succeeded in building a small, simple unit capable of giving either pulse-width or pulse-amplitude modulation at will. However, this gear has not been applied to a transmitter, for the New Zealand regulations do not at present allow pulse modulation to be used on any band.

Thus, until the decisions of the recently concluded international conference are made public, and until our regulations are re-drafted to take pulse modulation into account, it is unlikely that permission will be granted to amateurs in this country to use the new modulation systems that come under this heading.

It is much to be hoped, however, that the situation is speedily rectified. It could be if amateurs so desired, for there is no reason to believe that the N.Z.A.R.T. would not obtain a sympathetic hearing from the Post and Telegraph Department should it ask for pulse to be permitted on the existing V.H.F. amateur bands.



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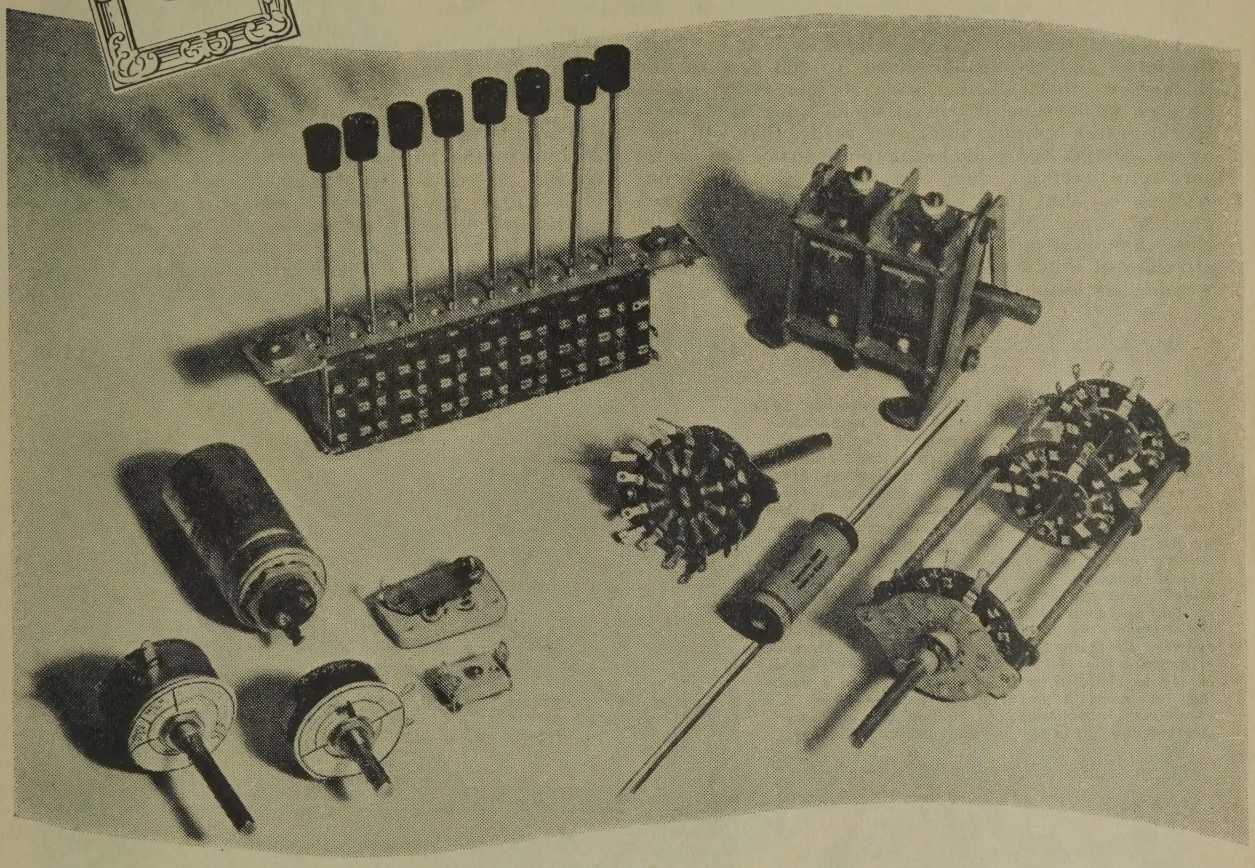

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A New All-Weather Airport Approach Light System

By W. A. PENNOW, Section Engineer, Street, Aviation, and Marine Lighting, Western Electric Corporation, Cleveland, Ohio.

A new all-weather approach light system has been developed that is visible through 1000 feet of the thickest weather, when objects 50 feet away cannot be seen in daytime. The system includes flash units, the brightest lighting units ever made, that will give up to 3,300,000,000 peak beam candlepower for use in zero-zero daytime, and blaze units that are controllable so that they can be set to emit a soft red glow of about one hundred candlepower for use on clear, moonless nights. Between these two extremes are steps of candlepower suitable for any intermediate weather conditions.

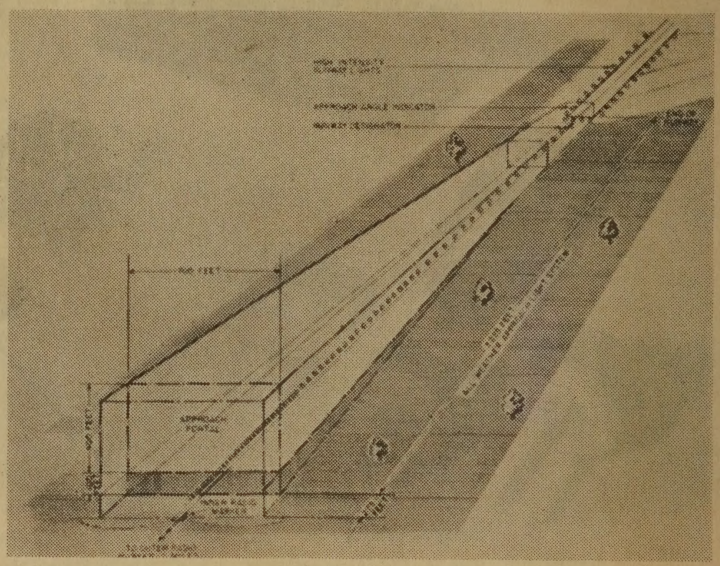

Fig. 1.—The operation of the all-weather approach light system is shown in this diagram. The pilot is directed by instruments to the approach portal, the imaginary frame 400 feet high and 700 feet wide at the lower left of the diagram. Here a radio signal indicates that he must leave instruments and search for visual contact. Within this area he is guided, despite zero-zero visibility, by the brilliant flashes from the approach line extending nearly two-thirds of a mile from the approach portal to the beginning of the runway. Judging altitude and direction by the appearance of the approach line, the pilot descends toward the runway threshold. At the beginning of the runway, the runway designator is in the form of a green arrow for a last-minute all-clear signal or can be changed by the control officer to a flashing red cross if the runway is obstructed. To assure safe completion of the landing, high-intensity runway lights outline the runway brilliantly.

Preliminary tests at Cleveland Municipal airport have proven that the bad weather problem of disrupted schedules and endangered lives and planes can be practically eliminated at airports where this new system is installed. These tests have shown that the transition from instrument approach to visual landings can be accomplished easily under any condition of fog. The tremendous range of candlepower permits all approaches to be made during any kind of weather, day or night, so that full instrument procedure becomes routine and bad weather introduces no new problems.

The system requires no additional equipment on the plane. It works equally well with any type of instrument approach system: Instrument Landing System (ILS), Ground Controlled Approach (GCA), or Microwave. It is the first system of lights with enough power to be of use in foggy daytime, and with characteristics that cannot be mistaken for any other type of light.

The complete system consists of three parts, the approach line, the runway designators, and the high-intensity and runway lights. Each of the parts does a specific job.

APPROACH LINE

The approach line is a single line, parallel to and 25 feet to the left of the extended centreline of the runway as shown in Fig. 1. These lights are the pilot's first visual contact with the ground as he leaves instruments while passing through the approach portal. In heavy weather when the lights are operated at the higher intensities, they are flashed successively, one after another, to give the effect of a streak of lightning travelling toward the end of the runway. A central instrument controls the actions so that the outermost unit flashes first and each successive unit toward the runway flashes just before the light from the preceding unit appears to be extinguished. This vastly increases the visibility of the system, as the eye will perceive relatively lower apparent candlepower if positively guided to it.

Flash and blaze units are spaced alternately in the line, 25 feet apart for the outer 900 feet, 50 feet apart for the middle 1000 feet, and 75 feet apart for the threshold. The line extends 3225 feet out from the inner 1200 feet, with the last unit 150 feet from the threshold to within 275 feet from the middle marker of the instrument Landing System. All units are aimed at the centre of the approach zone at a point 6000 feet from the threshold and at 1000 feet elevation. The beam spread of each unit encompasses the normal approach portal.

The flash units shown in Fig. 2 are extremely high-powered lights used for flashing service only during

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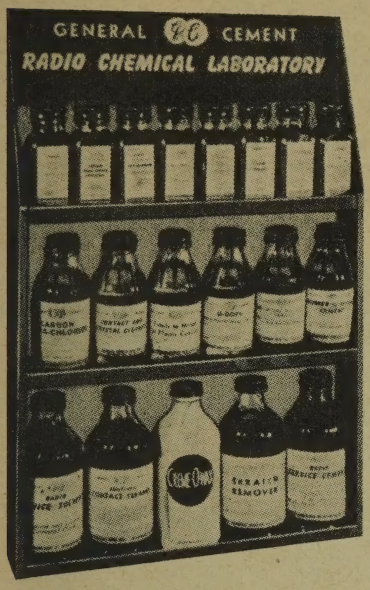

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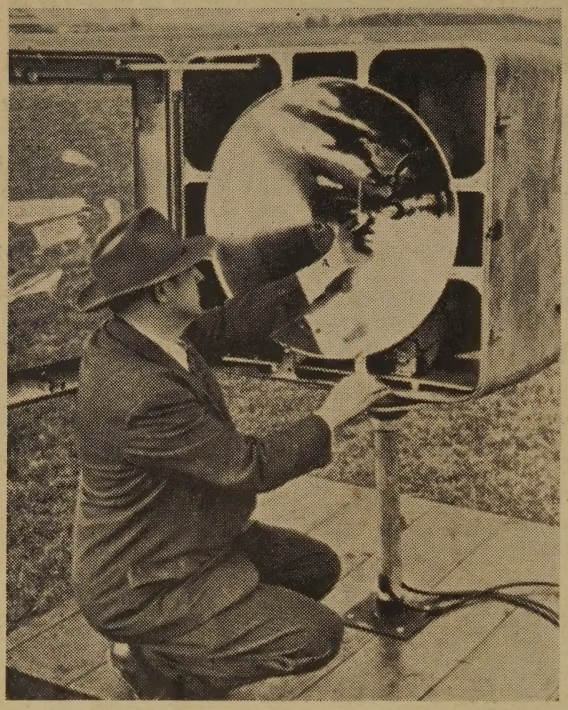

Figure 2.—Part of the approach line, this 3,300,000,000-candle-power krypton light will penetrate 1000 feet of the densest fog to guide planes safely to a landing. Although the light source is only about two inches long, the brilliance of the beam after being concentrated by the reflector is greater than that of the sun.

daytime weather of half-mile or less visibility and night weather of 500-foot or less visibility. They are operated at calculated peak brightnesses of about one million beam candlepower on "low" or about three billion, three hundred million candlepower on "high." An entirely new type of lamp is used. It is a small, extremely high-output lamp filled with krypton, one of the rarest of gases. The lamp itself produces a maximum brilliance of nine million candlepower per square inch which is magnified by the reflector and optical system to three and a third billion candlepower. An idea of its power can be obtained from its energy consumption, which is at the rate of over three million watts during the peak flash period. The light source is a little smaller in diameter than a lead pencil and only about two inches long. The use of heavy-walled fused quartz tubing is required—other materials would melt or burst under the heavy discharge at the peak of the flash.

The blaze units are used almost continuously on the approach line day and night, operating as steady-burning lights during weather ranging from clear to hazy daytime and from clear to light fog at night. In thicker weather they operate as flashing lights, complementing the flash units. On steady burning service, they produce either 100, 1,000, or 10,000 candlepower, as selected, and on flashing service they operate at about 100,000 or 10,000,000 candlepower as needed. Six lamps are used in each blaze unit. Each lamp shown in Fig. 3 is about two feet long and as big around as a fountain pen, and is similar to a neon tube except with special electrodes and gas filling to permit operation at different brightness levels.

The approach line is a pale red line of 100 candlepower units on clear nights, a bright red line of 1000 candlepower units on clear days and hazy nights, or a brilliant red line of 10,000 candlepower units during hazy days and light fog at night. Then the line appears as a lightning stroke of 100,000, 1,000,000, 10,000,000 or 3,300,000,000 candlepower as needed for increasingly worse weather. This great range of candlepower, from 100 to 3,300,000,000 gives positive visibility in any kind of weather. Table I gives settings and penetration of the approach line for the complete range of visibility conditions.

TABLE I

Approach Light Brightness Table

WEATHER CONDITIONS		APPROACH LINE	
	Max. Daytime Visibility	Flash Unit Setting	
Type of Weather	Condition	Day	Night
Clearest	30 miles plus	off	off
Very clear	30 miles	off	off
Clear	10 miles	off	off
Light Haze	5 miles	off	off
Haze	2 miles	off	off
Thin Fog	1 mile	off	off
Light Fog	½ mile	low	off
Med. Fog.	¼ mile	low	off
Heavy Fog	500 feet	low	low
Dense Fog	200 feet	high	low
Zero Zero	50 feet	high	high

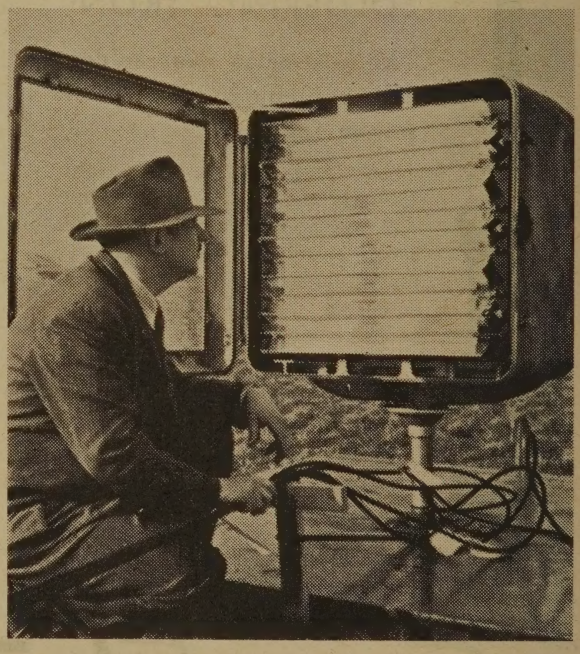

Figure 3.—This group of neon lights mounted within the reflector will aid the krypton units in piercing fog in bad flying weather or can be used alone when visibility is better. When mounted in the reflector, their brilliance can be varied from a 10,000-000-candle-power flashing beam to a steady 100-candlepower glow when visibility is good.

SETTINGS AND PENETRATION

Blaze Unit Setting		Approach Light Minimum
Day	Night	Penetration
med. steady	low steady	2 miles
med. steady	low steady	2 miles
med. steady	low steady	2 miles
high steady	low steady	2 miles
high steady	med. steady	2 miles
low flash	med. steady	1 mile
off	high steady	3500 feet
low flash	low flash	2500 feet
high flash	low flash	2000 feet
high flash	high flash	1500 feet
high flash	high flash	1000 feet

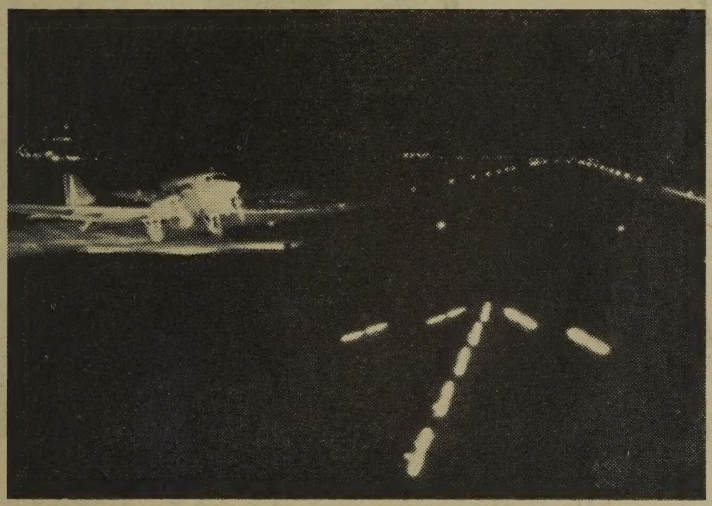

Figure 4.—To direct runway traffic in the all-weather approach light system, this type of green arrow is mounted at the head of the landing runway. The one shown above is installed at the National Airport, Washington, D.C., but is slightly shorter than the 83-foot arrow planned for the all-weather system. When the runway is not all clear, the control officer in the airport tower can change the arrow to a flashing red cross. Both the cross and arrow are formed by a combination of 16 lamps.

RUNWAY DESIGNATOR

The second part of the system, the runway designator, consists of an assembly of luminous tube elements forming either a green arrow or a red cross. A similar installation but slightly smaller than that planned for the all-weather system is shown in Fig. 4. The green arrow indicates that the runway is clear for landing while the flashing red cross shows that it is closed. During good weather, designators at each end of each runway are used as traffic control aids to relieve the load on radio communications between the control tower and incoming airplanes. Only an initial contact with airplanes nearing the airport traffic pattern to assign landing sequence and give wind data is required. The designator is a large green arrow pointed toward the runway that is clear for landing. At all other ends of runways, the designator is a large flashing red cross, showing it is closed for landings. As an airplane passes over the green arrow, the control officer changes the arrow to a flashing red cross closing the runway until the airplane has landed and cleared the runway. It is then changed back to the arrow, instructing the next airplane in the landing sequence pattern to proceed.

During instrument weather the designator is a last-moment safety signal to the approaching aeroplane. The green arrow is assurance to the pilot that the runway is clear and that he is at the proper position to make a landing. If an emergency arises that makes the runway unsafe for a landing, the flashing red cross is a warning to pull up and resume position in the traffic pattern until the emergency is cleared.

HIGH-INTENSITY THRESHOLD AND RUNWAY LIGHTS

The third part of the system consists of the high-intensity threshold and runway lights spaced at 200-foot intervals, 10 feet out from both sides of the runway borders that produce candlepowers up to 100,000. This is one hundred times the candlepower of the semi-flush runway lights in common use, and nearly three times that of the high-intensity runway light used by the Armed Forces. The new high-intensity runway light uses three lamps and can be operated as a high-intensity or a low-intensity unit. For high-intensity service, two sealed-beam lamps are used, one for each operating direction on the runway. These lamps, only one of which is used at any time, are operated at 100,000, 30,000, 10,000, 3,000, or 1,000 candlepower. For low-intensity service, the high-intensity lamp is turned off and a single lamp mounted in a two-directional optical system at the top of the unit is used. Like the larger lamp, it has five steps of intensity, and can be operated to give 500, 150, 50, 15 or 5 candlepower. These ten steps match the ten steps of brightness available in the approach line. The threshold, or start of the runway paving, is marked by a line of 6 or 8 green lights across the end of the runway, arranged with an 80-foot wide gap in the centre. During weather when the top element only is used, the emitted light is in two directions with some light all around. In thick weather, when higher candlepowers are used, all emitted light is severely restricted to the direction of approach. This prohibits background lighting and prevents lighted haze or fog curtains behind each light that would reduce perception of the next light in the line.

The colour of the runway light's lens is determined by its position along the runway. Clear light is used along the outermost section of the runway and yellow indicates to the pilot the last 1,500 feet. When used as range lights at the very end of the runway, the lenses are coloured green.

ANGLE APPROACH INDICATORS

As a training means to aid pilots in becoming accustomed to making all approaches and landings as near to the correct instrument approach path as possible, a fourth type of light is used. Mounted in pairs, one on each side of the runway about 600 feet in from the threshold, approach angle indicators project tri-coloured sandwiches of light toward the

(Continued on page 47.)

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Fault Finding With The Oscilloscope

By "M.R.S.G.B."

In previous articles on the subject of "Trouble Shooting" mention was made of the use of the cathode ray oscilloscope for the accurate and visual alignment of radio receivers. Consideration is now given to the use of this instrument for fault tracing.

INTRODUCTORY

The cathode ray oscilloscope is a very versatile instrument and, due to the fact that it absorbs very little power from any circuit across which it is connected, finds a ready place in a great many applications in the electronic field. Perhaps one of its main attractions lies in the screen image which visibly indicates what is occurring in the circuit under investigation to the experienced engineer, and the instantaneous result of any adjustments made. But to reap the maximum benefit from its use it is essential that the operator be conversant with the practical meaning of the various "pictures" on the screen. Practice and experience and plenty of it are a *sine qua non* for its efficient use.

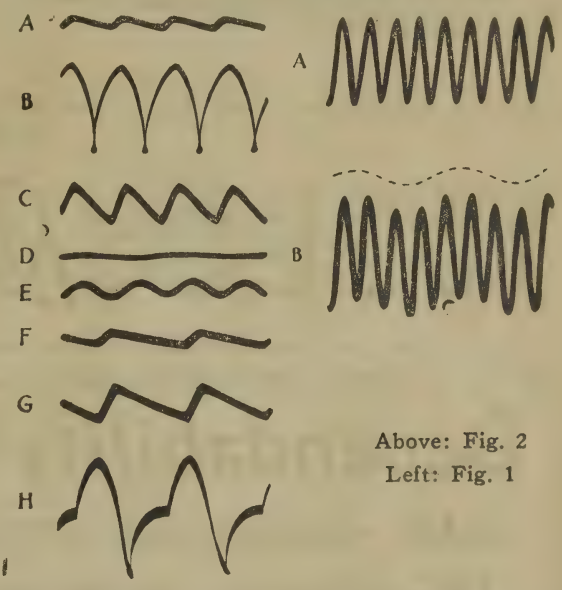
For the benefit of those who are not familiar with the 'scope a good beginning may be made by considering the manner in which it may be used in the detection of certain faults commonly met with in radio servicing. Such tests as are outlined here should be followed up by widening their range with miscellaneous examinations at various points throughout a receiver in good order in comparison with similar tests carried out on faulty or indifferently operating receivers. In this manner a fund of useful data may be collected for later application.

RECEIVER HUM

The most usual seat of this complaint lies in the smoothing system of the power supply of mains operated sets, and this will make a useful starting point. We will assume the more usual condenser input filter where there is an input or reservoir condenser, a choke or speaker field and an output or smoothing condenser. The Y plate amplifier of the 'scope will be used in conjunction with the gain control which, to start with, will be adjusted to a low value. We do this because we are only interested in the ripple voltage which is superimposed on the high D.C. voltage. By using the amplifier the D.C. component is eliminated and the only fluctuations which will appear on the screen will be due to the A.C. ripple. The mains frequency is 50 c/sec., so that the rectified frequency with full-wave rectification will be 100 c/sec. In order to obtain a repeat pattern it is necessary to set the time base at some submultiple of the rectified frequency so as to lock the image. If the time base is set to 20 c/sec. we shall have five repeats of the waveform on the screen.

The procedure, then, is to connect the earth terminal of the 'scope to the chassis or receiver ground, set the coarse frequency control to the 20 c/sec. range and, keeping the gain low, connect the Y amplifier terminal to a suitable point in the circuit under test, in this case at the output of the rectifier. Adjust the fine frequency control and synch. control until the image locks on the screen to show five or six wave patterns. If the amplitude is too small for ready legibility the gain control can be turned up till a satisfactory picture is obtained—which, if all is in order, will show a slight ripple effect as in Fig. 1 (a). The similarity to textbook diagrams of ripple voltage for full-wave rectification will be immediately recognized.

But suppose we do not get this image, but something like Fig. 1 (b), what is to be inferred? As we are at the input it follows that the reservoir condenser is charging and discharging excessively owing to very little capacity, or what is more probable, actually not functioning at all due to being open circuited and hence we obtain the full-wave rectification pattern. If the ripple is very pronounced as in Fig. 1 (c)

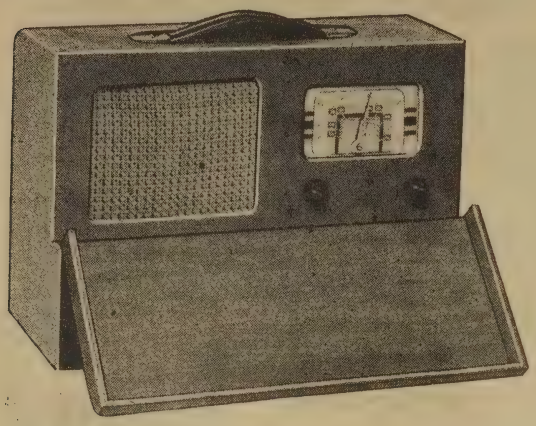


Above: Fig. 2
Left: Fig. 1

the implication is again too low a capacity for the input condenser and hence the heavy charge and discharge pulsation which would not be sufficiently smoothed out by the choke and second condenser.

Now connect the Y amplifier terminal to the filter output and if all is in order we should expect to see a straight line (i.e., no ripple) even if the gain is turned up some 20 times. With still greater gain we may obtain a slightly undulating line as shown at (d). Supposing our image showed a slight irregularity which, on turning the gain up, showed up a pattern similar to (a)—assuming that the input had been proved for satisfactory operation—then we must infer that the second condenser is not functioning as the reduction in ripple would be that due to the inductance of the choke. The condenser must have too little capacity or be open circuited, perhaps due to the drying out of the electrolyte.

Suppose that in our preliminary inspection we had decided that both electrolytics required renewing and carried out this step, and found that hum still persisted. If the Y amplifier is connected we shall probably see a smooth undulation as in Fig. 2 (e) even with the gain turned down. In this case it is certain that the smoothing choke is short circuited or partially so depending on the amplitude of the undulation.



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If half-wave rectification is used, as may be found with some old timers, the wave-forms will vary from the foregoing. Connection of the Y amplifier to the input condenser will give the elongated ripple of Fig. 1 (f) if all is in order, as will be seen from comparison with Fig. 1 (a). If the input condenser is drying out and only giving very small capacity, the ripple will show up as a pronounced sawtooth as at (g), while a complete open circuit will result in the pattern (h) which is the half-wave version of Fig. 1 (b). The indications of readings at the filter output will be similar to those already described if due allowance be made for the half-wave system as above.

In these tests the most important factor is the AMPLITUDE of any irregularity rather than the actual shape, as it is the amplitude of the A.C. ripple that causes the hum.

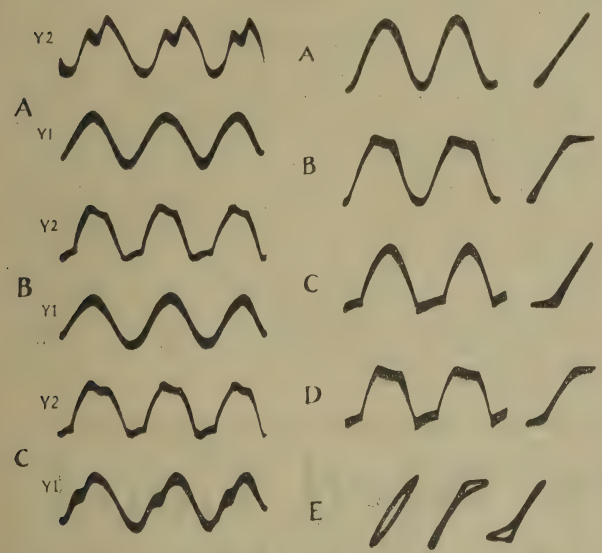


Fig. 3

Fig. 4

Assuming full-wave rectification, hum produced in the H.T. line will be at 100 c/sec., but if hum is occurring at 50 c/sec. it will be due to unrectified supply—that is, the heater line. With directly heated valves this will probably be due to the L.T. earthed centre tap being off-centre and is easily remedied. With indirectly heated valves the cause will probably be a heater-cathode leak and the 'scope can be used to locate the faulty valve as well as to prove the frequency of the hum. For this purpose the signal generator is added to the set-up (the instrument should be capable of producing a reasonably pure sine wave whether modulated or unmodulated) and a modulated signal injected into the aerial-earth terminals of the receiver which is then tuned exactly. The 'scope is connected, via the Y amplifier, across the speech coil and the time base set at a submultiple of one of the mains frequency. With no hum present the screen image should appear as in Fig. 2 (a), but if hum is present the envelope will be modulated as shown at (b) and will probably be wriggling as well as the "400" c/sec. A.F. modulation is not likely to be exactly at 400 c/sec. and so will not lock with the time base. The number of complete waves will determine the frequency of the hum when the time base frequency is known.

The actual faulty stage can now be picked out by connecting the signal generator to anode and grid circuits of each valve starting with the output. Naturally, only the A.F. 400 c/sec. output will be used in the L.F. section, decreasing the signal amplitude as you work towards the detector. After the detector the modulated R.F. signal will be used, first with an I.F. signal up to the converter valve, and then a B.C. signal to the aerial, and noting the point where the hum modulation appears.

For practice and experimental purposes hum can be artificially produced by connecting a variable resistance, say a ¼ meg. "pot.," across the heater-cathode of a valve to serve as a "leak," and then note the hum modulation as the "leak" is increased by reducing the resistance value.

TRACING DISTORTION

For the tracing of distortion it is advisable to use a distortionless input, so that, before making any tests the signal generator should be checked on the 'scope by connecting the output to the Y amplifier and earth terminals and setting the time base to give four or five complete waves in the usual manner. If it is found that the generator does not deliver a good sine wave form—assuming that the Y amplifier is distortion free—it is possible to use the 50 c/sec. mains stepped down to a suitable voltage via a transformer and a variable resistance, the L.T. winding of an ordinary mains transformer is quite suitable. Injection should be made at the "gram." pick-up terminals or grid circuit of the first L.F. amplifier. It is also convenient to use a double beam 'scope as the wave-form can be checked simultaneously at two different points. One Y plate will be connected across the input and the other Y plate across the speech coil and ground (for which purpose the coil must also have one side grounded). If our input is too large the output valve will be overloaded and distortion will occur—if the power valve is a pentode the two traces will appear something like Fig. 3 (a), but if it is a triode the result will be similar to (b). Suppose the first Y plate is removed from the input and connected to the grid of the power valve and we obtain traces as shown at (c), it will be seen that some distortion has crept into the grid connection (lower trace) and it follows that it must have been introduced between the input and this grid.

In practice it is convenient to fit a test prod to one or both of the Y plate leads so that various points in the circuit can be readily touched till a point is reached where distortion no longer occurs—the fault then lies between this point and the next one where distortion is evident.

THE I.F. SECTION

Distortion is often present in the I.F. section of a receiver and is not easy to trace by ordinary methods, aural or otherwise. But if a modulated I.F. signal is injected into the grid circuit of an I.F. valve and the 'scope connected across the secondary of the I.F. transformer we should get a picture like a normal modulated carrier, where the waved edges represent the 400 c/sec. modulation. The time base of the 'scope is locked to some submultiple of the 400 c/sec. modulation to give four or five repetitions. Overloading of the valve—perhaps due to ageing or alteration of the grid bias—is shown up as a flattening of the

peaks of the envelope. It may be found that the 'scope leads detune the I.F. transformer, but this can be compensated for by peaking with the trimmer for maximum response on the screen.

The R.F. section can be similarly checked as long as the signal frequency is not too high for the instrument.

A.V.C. CHECKS

A.V.C. action can be simply checked by feeding a small modulated R.F. signal into the receiver which is then tuned exactly. Connect the 'scope just prior to the second detector or immediately following it. A modulated envelope as shown at Fig. 5 (a) will be obtained. The signal input is then gradually increased. The envelope amplitude will also increase up to the point where delay voltage is reached, and thereafter there should be practically no visible growth on increasing the signal.

ALTERNATIVE METHOD OF CHECKING FOR A.F. DISTORTION

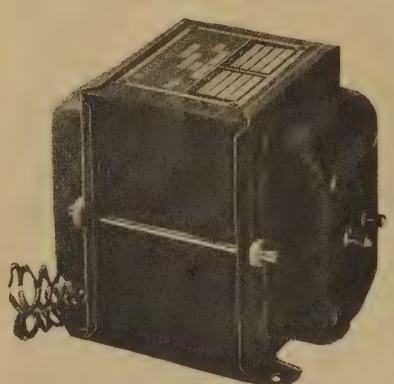
We will conclude by describing a method of testing for A.F. distortion using an impure input, which is based on the fact that if the X and Y plates are fed from the same voltage, which need not be pure sinewave in form, the resulting image will be a straight line inclined at 45 deg. to the horizontal. If the signal generator output is fed to the X plates (the normal time base being cut out) via an amplifier and also directly to the input of a particular stage across whose output the Y plate amplifier is connected we fulfil the condition above and should obtain the inclined line of Fig. 4 (a). If the trace appears as at (b), the inference is that the upper peaks are flattened as shown due to insufficient grid bias or ageing of the valve. On the other hand, if the input is increased and we get a line as shown at (c), we know that the grid bias is excessive and that we have encroached on the lower bend of the characteristic. The line of (d) shows that the peaks have been flattened at both ends, which points to a shortened characteristic due to low H.T. and insufficient bias and thereby making the grid swing more than "fill the valve."

If plain single lines are not obtained as at (e), the indication is that there is some phase shift present. This need not cause concern, as most amplifying stages produce various degrees of phase shift at different frequencies and these do not affect the reproduction.

CONCLUSION

The foregoing remarks should be sufficient to show the manner in which the oscilloscope can be used to check receiver performance at any point in the circuit, but we would stress again the importance of carrying out personal tests until adequate practical proficiency is attained. The handiest method is, undoubtedly, to work with a good receiver—obtain a screen pattern and then to deliberately introduce some defect and compare the results. This procedure gives valuable direct evidence of cause and effect, and provides the experience so necessary for the intelligent reading of the underlying meaning of the screen image; after all, unintelligible pictures are not of much practical value!

Good Speakers Need Good TRANSFORMERS



When tested in an identical KT66 amplifier, this outstanding transformer had a flat response from below 10 cycles to above 20 kilocycles, and proved capable of handling full power output at 20 cycles with less than 1 per cent. distortion. Transformers having similar characteristics are available to suit the "Radio and Electronics" DA30 amplifier and can also be made to suit special requirements. Normal secondary impedances are 10 and 15 ohms.

Performance figures show that Beacon Output Transformers give superior results.

Characteristics of a typical Beacon Transformer designed to suit the April *Wireless World* KT66 amplifier compare more than favourably with the overseas specifications.

W.W. Specifications:		Measured Beacon Performance
Primary Inductance (with 5 volts 50 cycles applied)	95 Henries	135 Henries
Leakage Inductance	33 mH.	25 Millihenries
Primary Resistance	250 ohms	280 ohms
Iron Distortion (at 25 cycles, without feedback)	Not quoted	0.3% at 15 watts
Core material	Silicon Steel	Nickel Iron

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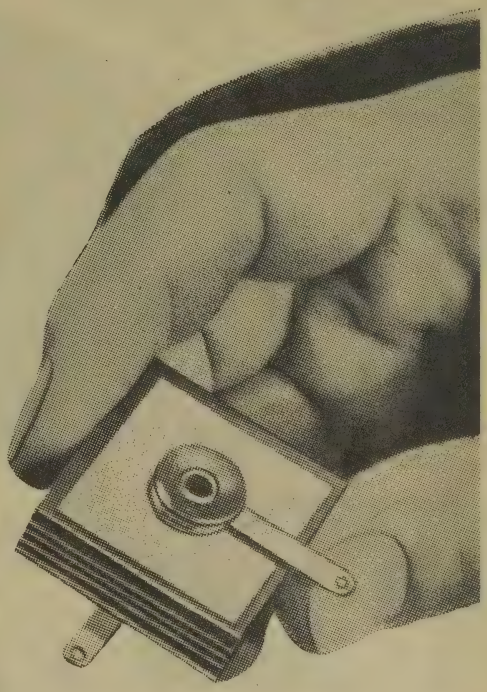

The new miniature 5-plate Selenium Rectifier perfected by S.T.C.'s associate company, the Federal Corporation of America, is designed to replace all conventional rectifier tubes in home radios. For years Selenium Rectifiers have been utilized in electronic circuits, but their space requirements and high costs made them impracticable for use in radios.

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Replaces 29 different rectifier tubes and sockets. When used in voltage doubler or tripler type circuits it eliminates transformers. Leaves much more room in the chassis—reduces product size—reduces weight—starts instantly without warm-up—runs cool—withstands heavy overloads—has greater reserve power—lasts the life of the set—trouble free, won't break. Cuts manufacturing costs. Speeds production. Stimulates sales. Nothing so new or so revolutionary.

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Manufacturers who have used the miniature Selenium Rectifier over a long period continue to report the accelerating scope of its applications. Using it *in place of tubes and transformers* in an ever increasing range of electronic equipment, they are effecting vast savings in production time and production costs. Moreover, it is now possible to introduce ideas with a special appeal for consumer-users who are looking for something really new.

FOUR SIZES—

75 ma., 100 ma., 150 ma., 200 ma.

Electrical characteristics of the 100 ma. Rectifier are:

Max. R.M.S. voltage, 130v.
Max. Inverse voltage, 380v.
Max. Peak current, 1200 ma.
Max. R.M.S. current, 325 ma.
Max. D.C. Output, 100 ma.
Approx. Rectifier drop, 5v.

You'll want to know more about this amazing miniature Rectifier, so write now to the sole New Zealand Distributors:

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AMPHENOL

Moulded Socket

NOTE THE DOUBLE SPRING-ACTION BLADES

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HERE is the most outstanding improvement in Valve Sockets in all the Radio Industry! Because of its absolute superiority and greater efficiency the AMPHENOL Valve Socket will eventually replace all the present wafer type Valve Sockets on the market. The new AMPHENOL MOULDED VALVE SOCKET positively resists vibration! It Improves Automobile Radio and All-Wave Sets. The AMPHENOL Moulded Socket is now ready, and we can give immediate delivery.
Vibration is nullified—perfect electrical and mechanical contact is maintained, reception is improved, and assembly costs are lowered BY THIS SIMPLE, RADICALLY DIFFERENT VALVE SOCKET.

Designers and manufacturers who KNOW have enthusiastically approved of the sensational features of the AMPHENOL MOULDED VALVE SOCKET.

ECONOMY is the one word for 1947-48 production! This masterly new vibration-resisting socket can actually be used to lower your production cost, as well as to heighten your set efficiency. It will outlive the set itself!

These AMPHENOL Moulded Valve Sockets can now be obtained from the INTERNATIONAL RADIO COMPANY, LTD., right throughout New Zealand and Australia.

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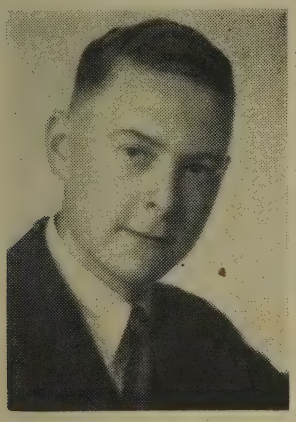
GOSSIP COLUMN

MR. R. D. GREENWOOD

For our personality this month, we have chosen Mr. R. D. Greenwood, Managing-director of National Carbon Pty., Ltd.

Born in Wellington 36 years ago, Ron was educated at Wellington College and Victoria University College. A Fellow of the New Zealand Institute of Cost Accountants (Wellington President), the Incorporated Institute of Accountants of New Zealand, the Chartered Institute of Secretaries, and the Institute of Industrial Management (Australia), Ron is also the founder and the Wellington President of the New Zealand Institute of Industrial Management, Inc.



Mr. R. D. Greenwood

As a professional accountant, he has had 13 years' experience in commercial and public accounting as a partner in the firm of Ernest Hunt, Turner and Co., Public Accountants and Auditors, of Wellington. Whilst with this firm, nothing was more remote from Ron's mind than becoming a member of National Carbon Pty., Ltd., but fortune would have it so, bringing it about in an unexpected way.

When with Ernest Hunt's, Ron was responsible for the introduction of a number of cost-accounting systems which brought him into close contact with many factory and sales operations—in fact, a large number of industrial concerns now use the systems originally installed by Ron. His first association with the battery industry was over the sale of the New Zealand Dry Cell and Battery Co., Ltd., of Christchurch, to the National Carbon Pty., Ltd., when Ron acted in an advisory capacity to the latter. After completion of negotiations, the National Carbon Pty. was so impressed with Ron's comprehensive grip of the business that in 1939 he was offered the position of General Manager for New Zealand, and in 1943 he was appointed to the Board, a position which he now holds.

At the outbreak of war, Ron volunteered for service with the R.N.Z.A.F., but on the day on which he was to leave for camp a telegram was received from Air Department "scrubbing" things.

Difficult times were ahead, and Ron proved himself in successfully solving the many problems arising during the war years. The colossal loss of staff and the near impossibility of obtaining raw materials were obstacles which would try the ingenuity of any man, but Ron and his staff built Eveready products to an all-time high standard. In one particular year almost 10,000,000 cells were produced.

During wartime, the need for skilled key men was so pressing that Ron instituted a training scheme within the National Carbon Co. to train men for these positions. So successful was this plan, that Ron then suggested to the principals of other industries that this training scheme might be introduced as a general industrial plan. Supported by 35 Wellington industrialists, a public meeting was sponsored by the Wellington Manufacturers' Association. As a result of this, the New Zealand Institute of Industrial Management was formed. Since then, Ron has addressed meetings at Auckland, Christchurch, and Dunedin, where branches have been formed with a membership of more than 500. Moreover, the Institute now employs its own full-time Manager.

It seems that he has a flair for founding things, as he was one of a committee which formed the Wellington Tuberculosis Association a couple of years ago.

Besides taking a very active part in many business organisations, Ron has also a variety of other interests which must keep his time well occupied. He is a member of the Council of the Wellington Manufacturers' Association, Inc., the Wellington Vocational Guidance Association (of which he is past-president), the Wellesley Club, the Wellington Commercial Travellers' and Warehousemen's Association, the Wellington Chamber of Commerce, the Wellington Employers' Association, the Wellington Manufacturers' Association (both Radio and Metal Trade Groups), and the New Zealand Radio Traders' Association.

Ron's chief interest lies with the Wellington Rotary Club, whilst his vacations are spent in mountaineering and dry-fly fishing.

* * *

The latest addition to George Wooller's rapidly-growing staff is Ross Pulham.

Ross has been connected with well-known radio organisations both before and since the war, and was with the New Zealand Torpedo Bomber Squadron in the United Kingdom for the greater part of the "duration."

We extend our congratulations to Ross—word having been passed down the grapevine that he has been presented with a son and heir.

* * *

Norm Chiswell, who has been with Swan Electric for some years, is now going on to outside work, and will be travelling in the Wellington Province for his firm.

* * *

J. Hey, of Hey's Harmony House, Hawera, was in Auckland recently, and made a deal with Bill Meighan to act as Taranaki representatives for Sheffield Radios.

* * *

Mr. A. F. Hayhurst, newly appointed field representative for National Carbon Pty. Ltd., has now taken up his duties, and is looking forward to contacting South Island retailers of Eveready products at an early date.

* * *

The American Institution of Electrical Engineers has appointed R. D. Neale, Canterbury University College, Christchurch, C.1, to be its local Honorary Secretary for New Zealand for the time being.

The local Honorary Secretary can deal with enquiries regarding membership and publications, and can handle applications for membership. Subscriptions, however, should be paid direct to the New York office.

(Continued on page 46.)

THE RADEL ALL-WAVE EIGHT

For a general view of this set, see the cover of last month's issue of "Radio and Electronics"

This receiver has been designed for the constructor who wants a really outstanding receiver worthy of a good console cabinet. It has a push-pull 6V6 output stage, an infinite impedance mixer, and is arranged to use a P.M. dynamic speaker. The eight tubes do not include the dual-sensitivity EM34 tuning indicator.

The receiver described in this article is the largest and best that has so far been described in "Radio and Electronics" for short-wave and broadcast listening purposes. It employs an EF39 R.F. stage, a 6F8-G (or 6SN7-GT) infinite-impedance mixer and oscillator combined, an EF39 I.F. stage, a 6B8-G second detector, A.V.C. rectifier and 1st audio, a 6SJ7 or 6SJ7-GT phase inverter, and push-pull 6V6's output stage. The rectifier is an 80 and the tuning indicator an EM34.

The R.F. end is built round any suitable coil-unit and gang condenser. The one used in the receiver illustrated had the following wave-bands:—**Broadcast,** 540-1800 kc/sec.; **Intermediate,** 1.7-6 mc/sec.; **Short-wave,** 6-20 mc/sec.

The use of an EF39 R.F. stage followed by an infinite-impedance mixer gives the set an exceptionally good signal-to-noise ratio and very fine handling qualities. The latter probably mean as much to the non-technical user as any other feature—thus the undoubted popularity of bandspread short-wave tuning—and is achieved in this case by means of the excellent oscillator stability, and remarkable absence of pulling, and drift due to A.V.C. action. These factors together produce a receiver which is as easy to tune on the short-wave bands as anything which does not employ bandspreading and, in fact, considerably better in this respect than many commercial receivers. The type of construction used almost eliminates oscillator drift on switching on from cold.

THE AUDIO AMPLIFIER

The audio amplifier is an excellent one in all respects, and is comparable in quality to a good push-pull triode amplifier, owing to the use of negative feedback and a well-tried voltage amplifier circuit. Feedback is taken from the plate of one 6V6 back to the screen of the 6B8. This method is one first recommended some years ago by A.W.A. in "Radiotronics," and works very well indeed. It has the advantage of providing all the benefits of negative feedback without causing any stage to provide more output voltage than it would normally have to without feedback. Thus the overall distortion is kept very low, since the 6B8 is working at the lowest possible level.

Associated with the audio stages in governing the low distortion of the set as a whole is the design of the second detector and A.V.C. circuit. The volume control potentiometer forms the load resistor for the detector diode, the moving arm being coupled through C_{13} to the 6B8 grid. This system ensures that detector distortion at high modulation levels is kept to a very low figure by reason of the fact that the shunting of R_{14} on R_{11} is kept very low in all but the highest volume control settings. This point is not always appreciated, with the result that some diode detector circuits are found in use which give very heavy distortion when the percentage modulation of the signal is high.

The well-known device is also used of feeding the A.V.C. rectifier through a small condenser, C_{10}, from the primary of the final I.F. transformer instead of from the secondary. It is not generally known that the signal voltage at the plate of the I.F. stage is a good deal higher than that at the secondary of the transformer, so that more effective A.V.C. results with this connection. Also, an advantage is that the selectivity at the A.V.C. diode is somewhat less than at the detector diode. This causes the A.V.C. to begin somewhat before the set is tuned to the carrier, with the result that the distressing sideband hiss, that occurs when some receivers are tuned across a station, is noticeably absent, making the set very quiet to handle.

MODIFICATION TO COIL UNIT

The use of the infinite impedance mixer necessitates a slight modification to the mixer section of the coil unit, but one which is very easily carried out. Most coil units have the A.V.C. bypass condensers already mounted in them. That is to say, the "earthy" end of the R.F. and mixer grid coils are earthed through a 0.05 or 0.1 mfd. condenser, and a wire is brought out from the bottom end of the coil for attachment to the A.V.C. line. The modification referred to above consists simply of removing the bypass condenser from the "earthy" end of the mixer grid coil, and directly earthing this end. As the coil units are normally constructed with the "earthy" ends of all three coils in each compartment connected in parallel, there is only the one connection to alter, and not one for each waveband.

COIL UNIT COLOUR CODING

The colour coding marked on the circuit diagram is adopted as standard by many coil unit manufacturers, but some still prefer to use marked terminal lugs instead of bringing out colour-coded wires. For this reason, it would perhaps be an advantage if the destination of the various leads were enumerated.

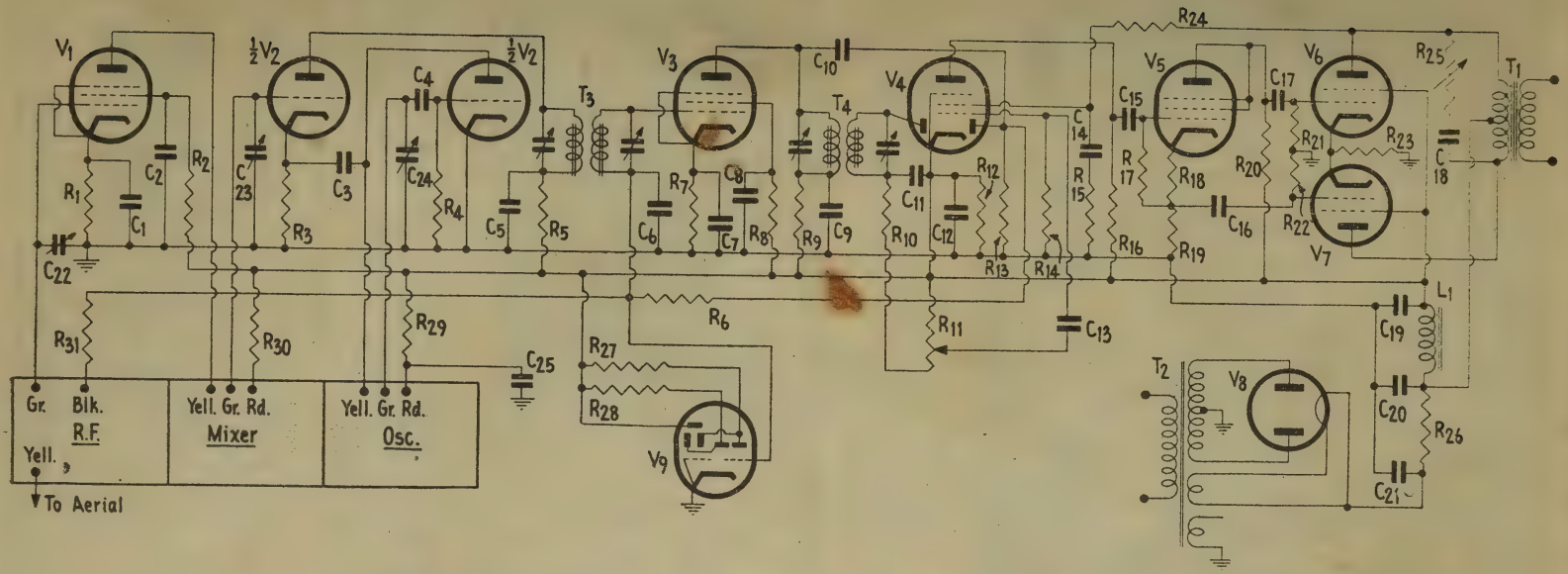
R.F. Compartment:
Yellow—Aerial.
Green—To R.F. tube grid and gang section.
Black—Through 50k. decoupling resistor R_{31} to A..C. line.

Mixer Compartment:
Yellow—R.F. tube plate.
Green—Mixer tube grid and gang section.
Black—Modified as above.
Red—Through 5k. decoupling resistor R_{30} to H.T.+

Oscillator Compartment:
Yellow—Oscillator tube plate.
Green—Oscillator tube grid and gang section.
Red—Through 50k. decoupling resistor R_{29} to H.T.+.

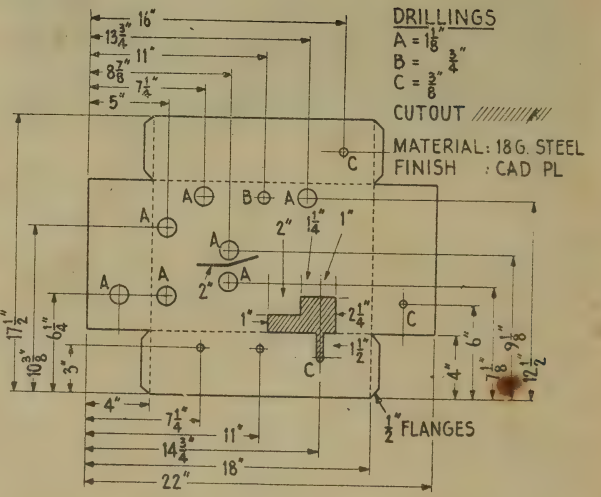
DECOUPLING AND BYPASSING

In this set rather comprehensive decoupling and bypassing has been used. R_{30} decouples the R.F. stage plate circuit in conjunction with a bypass condenser normally included in the coil unit. The latter should be examined to see if a bypass condenser is incorporated at this point or not. If not, a 0.05 mfd. paper condenser should be connected at the coil end of R_{30}.



COMPONENT LIST

V_1, V_3 = EF39.
V_2 = 6F8-G or 6SN7-GT.
V_4 = 6B8-G.
V_5 = 6SJ7 or 6SJ7-GT.
V_6, V_7 = 6V6 or 6V6-GT.
V_8 = 80.
V_9 = EM34.
R_1, R_7 = 350 ohms.
R_2, R_3, R_8, R_{10}, R_{19}, R_{20} = 100k.
R_4, R_{15} = 25k.
R_5, R_9, R_{18} = 1k.
R_6, R_{12}, R_{14}, R_{27}, R_{28} = 1 meg.
R_{11} = 500k. pot.
R_{12} = 1600 ohms.
R_{16}, R_{17} = 250k.
R_{21}, R_{22} = 500k.
R_{23} = 125 ohms 2 watts.
R_{24} = 1.2 megs.
R_{25} = 50k. pot.
R_{26} = 1k. 25w.
R_{29}, R_{31} = 50k.
R_{30} = 5k.
C_1, C_2, C_5, C_7, C_8, C_9, C_{15}, C_{16},
C_3, C_4, C_{11} = 100 mmfd. mica.
C_6 = 0.1 mfd. 400v.
C_{10} = 50 mmfd. mica.
C_{12} = 25 mfd. 25v. electro.
C_{13} = 0.01 mfd. 400v.
C_{14} = 0.25 mfd. 400v.
C_{17}, C_{18} = 0.05 mfd. 400v.
C_{19}, C_{20}, C_{21} = 16 mfd. 450v. electro.
C_{22}, C_{23},
C_{24} = 3-gang condenser, to suit coil unit.
C_{25} = 8 mfd. 450v. electro.
T_1 = output transformer 10,000 ohms to V.C.
T_2 = power transformer 385v.-0-385v., 5v. 2a., [6.3v. 4a.
L_1 = 20H. 50 ma.
T_3, T_4 = I.F. transformers, iron-cored.



The oscillator plate circuit is decoupled by R_{29}, which also serves to drop the oscillator plate voltage to a suitable value. In all probability a bypass condenser will be found in the coil unit at this place, too. If it is there, it should be retained and C_{25} added as shown in the circuit diagram. If no bypass condenser is incorporated the 8 mfd. condenser C_{25} should be sufficient in itself. The reason for this high value is that on some short-wave signals, in particular those subject to rapid fading, the H.T. current drawn by the controlled valves fluctuates at a similar rate to the signal. This in turn tends to cause similar fluctuations in the H.T. voltage, which may cause the oscillator to change its frequency slightly at each variation. Thus the total effect is to increase the depth of the rapid fade and make it appear much worse than it really is. This is known as the flutter effect, and may be entirely eliminated by means of the long time constant of R_{29} and C_{25}, which prevents rapid changes in the oscillator H.T. voltage even if the main H.T. voltage is undergoing slight fluctuations.

The plates of the mixer and I.F. tubes are also decoupled to prevent R.F. from getting back into the power supply and possibly causing either instability or loss of gain.

Intending constructors should note that these decoupling resistors and their associated bypass condensers should be mounted as close as possible to the points they are intended to decouple, for if they are not, the length of lead between the decoupling filter and the point to be decoupled can quite easily radiate to other parts of the circuit and completely nullify the effect of the decoupling filter in attempting to combat instability.

CONSTRUCTIONAL POINTS

The photograph of the underneath of the set shows how it is possible to tuck the small parts into place, both without overcrowding and without resorting to long leads. There will inevitably be long leads carrying H.T. and A.V.C. voltages, but these will cause absolutely no trouble if the decoupling networks are wired in as suggested above. Leads between the decoupling filters and H.T.+ can be as long as desired, and may pass anywhere through the circuit **as long as they are properly decoupled.** The tube layout shown in the chassis diagram ensures that all signal leads can be kept short and direct. This in itself is a great help in eliminating possible instability.

Mechanically, the set is very easily constructed, the only thing that might have to be made specially being the pieces of brass tube on which the gang condenser is mounted so as to bring the shaft to the correct height for the dial driving drum. The chassis as drawn enables the coil unit and dial to be mounted with a minimum of labour by the constructor.

CHASSIS DIAGRAM

The working drawing given herewith is a reprint of that for the "Radel Dual Wave Six," since this set and the present one are built on exactly the same chassis. The only difference is that two more 1⅛ in. holes are required to take care of the extra valves used by the audio amplifier. These extra valve holes are positioned as follows. There are two 1⅛ in. valve holes shown at the left-hand edge of the chassis. The back one of these holds the 6B8-G second detector and first audio tube, V_4. The front one is for V_6, one of the 6V6 output tubes. On a line with these two, and midway between them, a hole is required for the phase inverter tube, V_5. This leaves one more hole to be made, to take V_7, the second 6V6. To locate this, a line is drawn parallel to the front edge of the chassis, and through the centre of the V_6 socket hole. Along this line, measured 1½ in. from the centre of this hole, is the centre of the new hole for V_7. This arrangement can be quite readily seen by a reference to the view of this receiver which was printed on the cover of our last issue. In this photograph the valves are marked with their appropriate numbers.

Referring again to the chassis diagram, the right-hand valve hole at the back of the chassis is for V_8, the rectifier tube. The left-hand one at the back is for V_3, the I.F. amplifier tube. Right in the left-hand back corner of the chassis, between V_3 and V_4, is the second I.F. transformer, T_4, while the first I.F. transformer, T_3, is mounted to the front and slightly to the right of V_3, between it and V_2, which is the back one of the two valves near the centre of the chassis, next to the gang condenser. If any of this description is not quite clear, a reference to the cover of the last issue will set things right.

There is an omission from the chassis diagram of the mounting hole for the tone control potentiometer, R_{25}. This should be immediately below the hole for the wave-change switch shaft, which comes in the middle of the chassis front, and spaced 1¾ in. from the bottom edge.

THE TUNING INDICATOR

This uses the now well-known EM34 which has two shadow areas of different sensitivities. The tube has two plates but only one control grid and one target. It is thus very easy to apply, and requires only a single extra 1 meg. resistor, which is placed in series with the second triode plate.

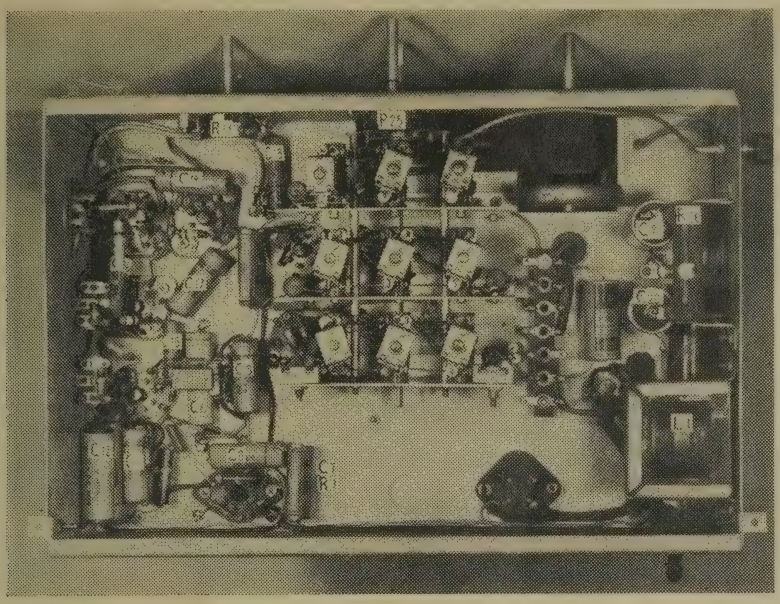
The manner of its working is rather novel and very useful. The part of the grid that controls the sensitivity shadow has a sharp cut-off characteristic which causes this shadow to close when only a small D.C. grid voltage is applied. When this sensitive shadow is fully closed, the insensitive one, controlled by part of the grid which has a remote cut-off characteristic, is only partially closed, and is operated fully only by a strong signal. Thus, the sensitive shadow gives a good indication on quite weak short-wave stations, while the insensitive one still operates satisfactorily on the large signals provided by most of the broadcast stations. In addition, the tube is so designed that neither shadow overlaps to give an extra-bright patch, however strong the operating signal may be.

POWER SUPPLY

The output of this set is remarkably free from hum, on account of the P.M. speaker, the push-pull output stage, and the two-stage smoothing circuit; the latter uses three 16 mfd. condensers, a small choke, and a 1000-ohm 25-watt resistor. The latter component enables a normal 385v.-a-side power transformer to be used, as without the voltage drop this resistor gives, the H.T. voltage would be too high, and would exceed the rating of the tubes. The choke is mounted under the chassis, and can be seen in the photograph.

OPERATION AND PERFORMANCE

There is nothing unusual about the operation of



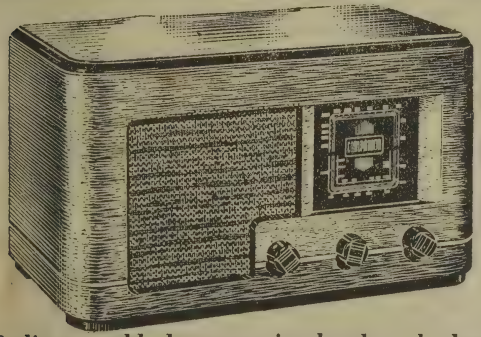
Under-chassis view of the All-wave Eight. The coil unit is in the exact centre of the chassis with the tone-control mounted directly underneath the wave-change switch shaft.

this set, as it has only the four normal controls, namely, tuning, wave-change switch, volume, and tone. In order to realize the best possible performance only high-quality parts should be used, especially in the R.F. portion of the receiver. Sensitivity, selectivity and equality of gain throughout the bands are all excellent in the original set, and will be in any that are built to these specifications, provided that a good coil unit (with the proper gang condenser for it) and high-quality iron-cored I.F. transformers are used. This is not a cheap set to build, and is not intended to be, but its handling qualities and performance generally make it well worth the outlay for constructors who want a domestic receiver with better-than-average power output, audio quality and shortwave performance.

AUDIO QUALITY

The audio quality of which the set is capable will depend largely upon the type of speaker and speaker baffle used with it. We strongly recommend the use

(Continued on page 47.)



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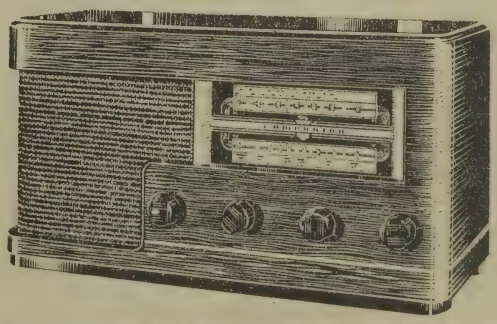

TUBE DATA: (1) TUBE NOISE IN R.F. AMPLIFIERS

All valves act as a source of noise on account of the inherently discontinuous nature of their space current. This noise is known as the **shot effect,** and is able to be calculated for a given tube, provided certain of its characteristics are known.

Shot effect noise is important only where the signal level is very low, as for example in the early stages of radio receivers or high-gain audio amplifiers. In a high-gain receiver the total receiver noise is the R.M.S. sum of the shot noise and of the thermal agitation noise which arises in the first tuned circuit. Thermal agitation noise may also be calculated, but is more difficult to remove from a receiver. It is also independent of the valves used.

Thus, in designing a high-gain receiver, the tubes used are of great importance to the weak-signal performance, and by a suitable choice may be almost eliminated as a source of receiver noise.

It is important, therefore, for set designers to have some means of comparing the noise produced by the tubes likely to be used, so that the quietest tube may be chosen for the first R.F. stage, other things being equal.

EQUIVALENT NOISE RESISTANCE

It is usual to express the noise performance of a tube by means of its **equivalent noise resistance.** This term needs a little explanation. In actual fact, the noise produced by a valve occurs in the plate circuit, due to the fact that this current is constant only when averaged over a relatively long period of time. Frome one microsecond to the next, however, the plate current variation is large enough that it may be heard as a noise in the output if it has been amplified sufficiently.

Now the thermal agitation noise produced by a resistor or a tuned circuit is caused by the random movements of the electrons in the conducting material. These movements amount to minute currents, if looked at for a sufficiently short period of time, and likewise may be heard in the output of an amplifier if they have been sufficiently amplified.

The concept of the equivalent noise resistance of a valve is simply a device for making noise performance easy to deal with in practice. It is arrived at by imagining that the tube itself is noiseless, but has connected in its grid circuit a resistor of such a value that its thermal agitation noise, after amplification by the valve, is equal to the actual noise produced by the valve's plate current.

TRIODES AND PENTODES

Triodes are inherently less noisy than pentodes or tetrodes. This is because the extra electrodes in the latter produce noise over and above that arising in the plate circuit only. Thus, an important factor in the noise performance of tetrodes and pentodes is the ratio between plate and screen currents under normal operating conditions. Other things being equal, the pentode with the highest ratio of plate to screen current will be the quietest.

There are other sources of noise in tubes apart from the shot effect and the partition effect, as it is called, but noise from these causes is usually much less in magnitude than the shot noise, and may consequently be disregarded.

FORMULAE

The formula for finding the equivalent noise resistance of a triode is very simple:—

$$R_{eq} = \frac{3000}{g_m} \text{ ohms}$$

where g_m is the mutual conductance under working conditions expressed in milliamps per volt. (To obtain milliamps per volt from micromhos, divide the latter by 1000, e.g., 3000 micromhos = 3 ma./v.

Thus a triode with a g_m of 3 ma./v. under operating conditions has an equivalent noise resistance of 1,000 ohms.

The formula for the equivalent noise resistance of a tetrode or pentode is:—

$$R_{eq} = \frac{1000\ I_b}{I_b + I_{c2}} \left(\frac{2.5}{g_m} + \frac{20\ I_{c2}}{g_m\ I_b} \right) \text{ ohms}$$

where I_b and I_{c2} are the plate and screen currents respectively, and g_m is the mutual conductance in milliamps per volt.

From the above it will be seen that

$$\left(\frac{I_b}{I_b + I_{c2}} \right)$$

which is the ratio of plate current to total space current, is an important factor in the noise resistance of a pentode or tetrode, as stated above. In addition, the formula shows that the equivalent noise resistance of this kind of tube will vary as the A.V.C. bias varies because the latter changes the ratio of plate current to screen current. In general, as A.V.C. bias is applied, the equivalent noise resistance increases, so that in very sensitive receivers there is a distinct advantage in either leaving the 1st R.F. stage uncontrolled by A.V.C. for weak signal operation, or in providing a large A.V.C. delay voltage, either method ensuring that there is no increase of set noise due to A.V.C. action on the 1st R.F. amplifier.

APPLICABILITY OF THE EQUATIONS

The above equations entail a number of simplifying assumptions, chief among which are that room temperature is 27°C. The discrepancy likely to be produced by this assumption is not very great, however, but may be the main cause of non-agreement of figures calculated by the formula, with measured figures stated by the manufacturers.

Nevertheless, the formulae given above give a very useful basis for comparing tubes, since most tubes use the same cathode material, and therefore employ similar cathode temperatures.

EXAMPLES

Using the formula for tetrodes and pentodes, the following figures were obtained for a number of well-known tubes:—

Tube Type	Equiv. Noise Resistance
6AC7/1852	680 ohms
6J7	4900 „
6SJ7	3750 „
6K7	3620 „
6SK7	3060 „
EF8	2360 „
EF39	2880 „
EF50	1000 „

It will be noticed that the figures given by the equation for the Philips types are all rather lower than those quoted by the manufacturers. This is due

to the fact that these valves are probably operated with somewhat different cathode temperature than are the American types. For instance the manufacturer's figure for the EF8 is 3200 ohms. Now, using the ratio 3200/2360 as a conversion factor, this gives a figure of $1.36 \times 2880 = 3900$ for the EF39, which is very close to the manufacturer's figure for this valve. Thus, for Philips-Mullard E series valves, it seems reasonable to use a factor of 1.36 times in conjunction with the formula. This process has been checked and found to give good results.

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(2) PLATE CHARACTERISTICS OF TYPES 6J5, 6F8 AND 6SN7

These curves continue our series of large-scale reproductions of the characteristics of commonly-used tubes. Types 6F8-G and 6SN7-GT are double triodes, each unit being provided with its own cathode, and identical in characteristics with the 6J5.

The curves therefore apply to each unit of these double types.

If the triodes of a double unit tube are connected in parallel, the curves may be made to apply by doubling the scale of plate milliamperes.

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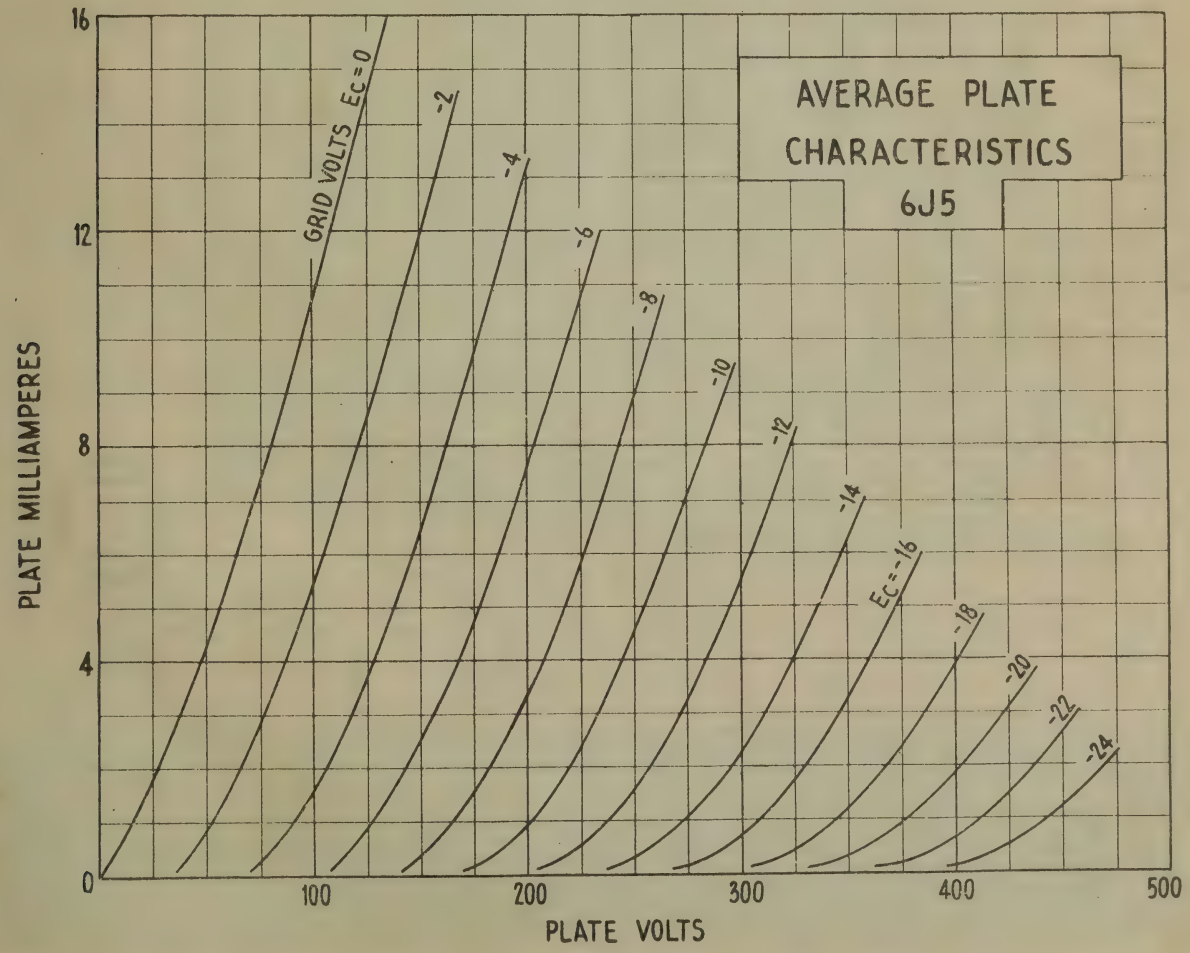
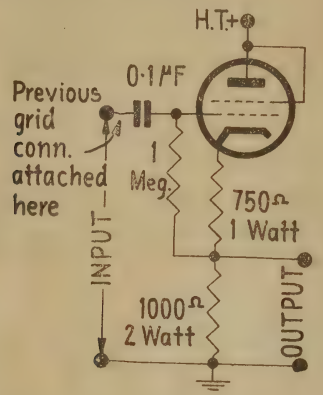


QUESTIONS AND ANSWERS

REPLACING THE POWER TUBE ONLY BY A PUSH-PULL AMPLIFIER

L. R. A., Christchurch, writes:—

"I have a commercial receiver fitted with a pick-up attachment, and find that the single 6F6 output stage gives insufficient volume on records. Could you please advise me of the necessary alterations so that I may use push-pull 6A3's resistance-capacity coupled? Is it possible to retain the tone control at present in the grid circuit of the 6F6?"



In our opinion, L.R.A.'s purpose would best be served by building up the "Enlarged 6A3 Amplifier" described in our June, 1947, issue, with the exception that V_1 may be omitted, and the output from the receiver chassis fed directly to the grid of V_2 through C_5.

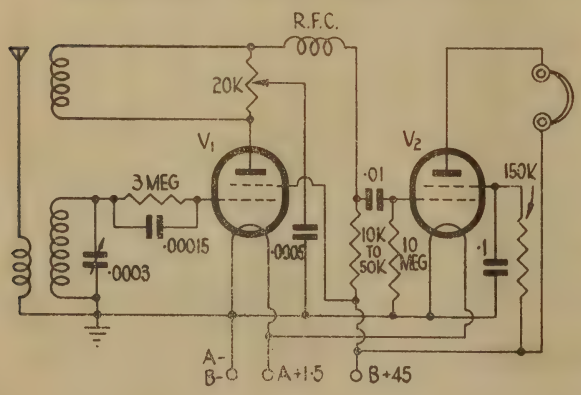
With this arrangement, the voltage amplifier stage in the receiver would be retained, and also the pick-up input arrangements.

The best scheme for coupling from the receiver is to use the 6F6 as a cathode follower in the accompanying circuit. The existing tone control arrangement may be retained, so that the input condenser shown will be necessary to prevent the original grid leak, which is removed from the 6F6 grid pin, from short-circuiting the 6F6 grid bias.

The double coupling is also necessary to ensure that the tone control works exactly as before.

* * *

ADDING AN R.-C. AUDIO STAGE TO A MINIATURE REGENERATIVE SET



G.R.McD., Wellington, writes:—"I send herewith the circuit of a midget regenerative receiver using a 1T4 miniature tube. I would be grateful if you could show me how to add a resistance-capacity coupled audio stage to it, as this would make almost no difference to size and weight."

We have pleasure in printing the accompanying circuit of the complete receiver. V_1 and V_2 are both 1T4's, the second working with grid-leak bias.

A disadvantage of this scheme is that the detector plate coupling resistor lowers the voltage at the detector plate, so that for best results (i.e., greatest overall gain) this resistor will have to be experimented with between the limits shown, and the best valve chosen by trial. The higher values might necessitate a somewhat increased coupling between tickler and grid coil compared with the amount required when the headphones are directly in the detector plate circuit.

* * *

USING THE "VIBRATOR FOUR" AS A CAR RADIO

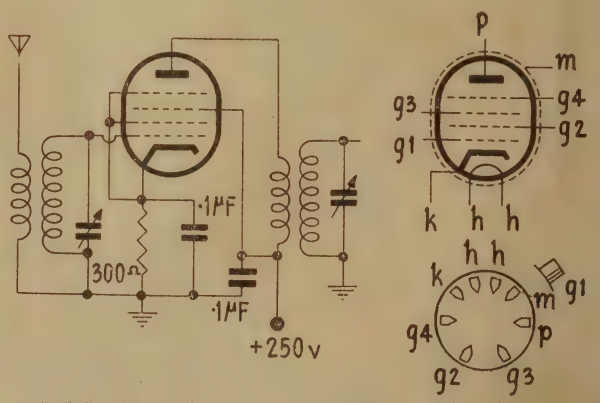
F.B.R., Porirua, writes:—"For some time I have been contemplating a car radio, and am wondering whether the vibrator set described in the March, 1947, issue of 'Radio and Electronics' would be suitable for building as a car set. Secondly, would the 6SN7 double triode R.F. stage be suitable for incorporating in the receiver? Would a 6Z7-G work satisfactorily in this circuit?"

The set referred to is the "Radel Vibrator Four," which is not entirely entirely suitable for using as a car set (a) because it has insufficient sensitivity, and (b) because for best results, the aerial input arrangements need to be specially designed.

With regard to the second question, there is no reason why the double triode R.F. stage should not be used ahead of the "Vibrator Four" circuit, but the 6Z7-G would not be suitable. Either a 6SN7-GT or a 6J6 should be used. It is recommended, too, that the mixer should be changed to an ECH35, which will give greater gain and less set noise than the 6K8.

* * *

USING THE EF8 LOW-NOISE PENTODE



P.J.S., Dunedin, writes as follows:—

"I have a number of EF8 valves which I would like to use, but unfortunately I have no useful data at my disposal. Could you please let me have a circuit diagram showing one of these tubes as a tuned R.F. amplifier?"

(Continued on page 47)

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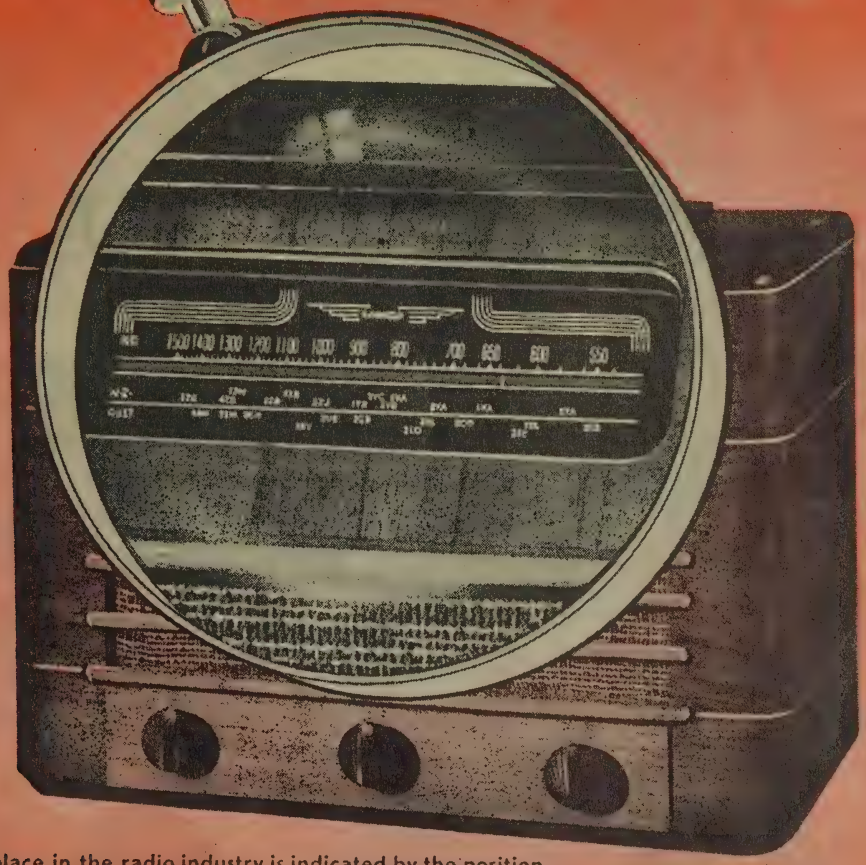

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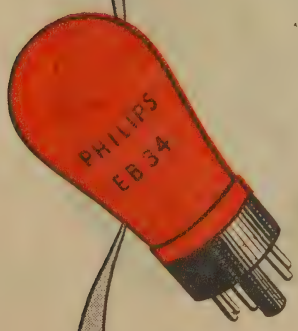

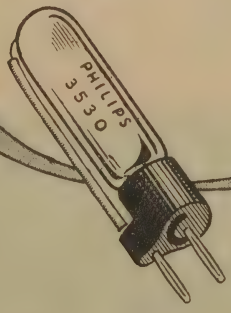

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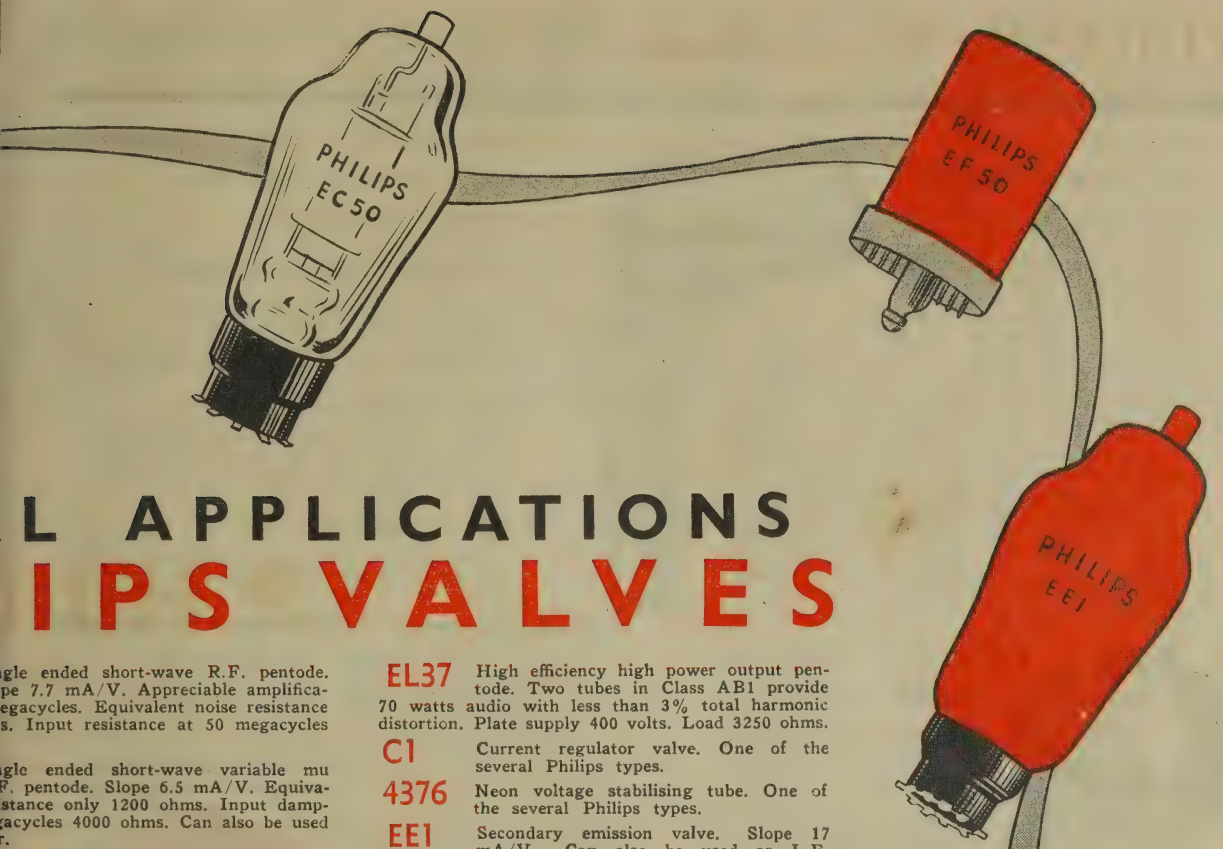

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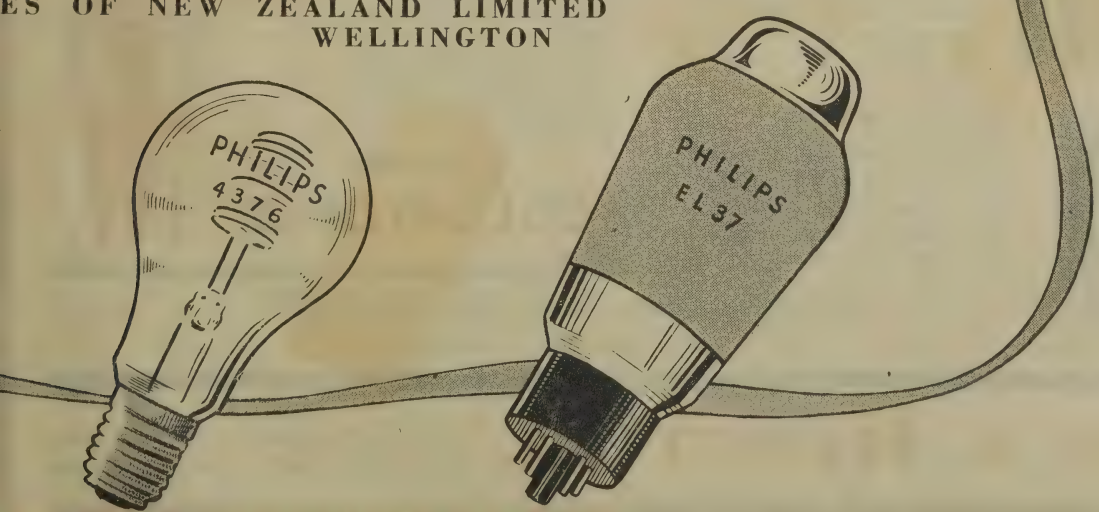

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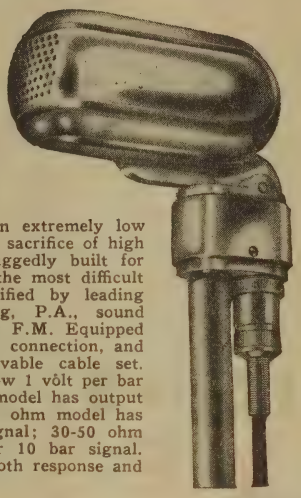

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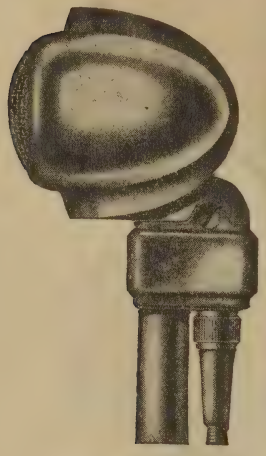

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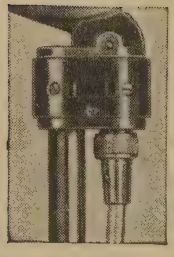

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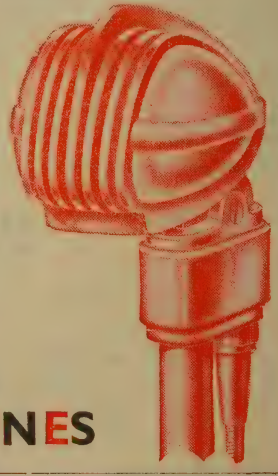

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A PRACTICAL ANALYSIS OF ULTRA HIGH FREQUENCY TRANSMISSION LINES, RESONANT SECTIONS, RESONANT CAVITIES AND WAVE GUIDES

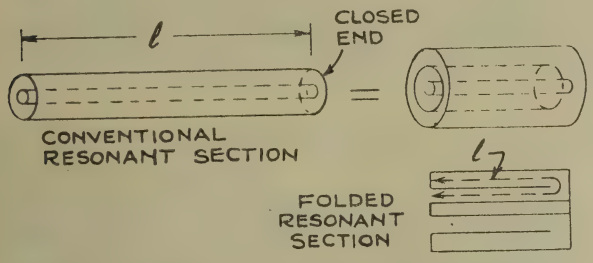
By J. R. MEAGHER and H. J. MARKLEY, R.C.A. Service Company Inc.

PART IV

MISCELLANEOUS APPLICATION OF TUNED SECTIONS

(5) "Folded" Resonant Section

At relatively low frequencies, the physical length of a resonant section may be too long for convenient use, and a "folded" section may be used. The effective length of the folded section is indicated by the dotted line. More than one "fold" may be used for further reduction of the physical length.



CHARACTERISTIC LINE IMPEDANCE

The impedance of a line (also termed "surge" or "characteristic" impedance) depends on the dimensions and spacing of the conductors, and the dielectric constant of the insulating material.

Neglecting losses—

$$Z \text{ ohms} = \sqrt{\frac{L \text{ HENRYS}}{C \text{ FARADS}}}$$

In solid dielectric lines (as compared with air dielectric), the impedance is reduced by the factor 1/K, where "K" equals the dielectric constant of the insulating material (and has the effect of increasing "C" per unit length in the general formula).

Aircraft antenna cable, using solid dielectric, is frequently 70 or 50 ohms. Seventy (70)-ohm cable is convenient for use with quarter-wave dipoles and other antennas that have a radiation resistance of 70 ohms. Fifty (50)-ohm cable is used extensively in conjunction with suitable matching on low-impedance array-type antennas.

The two charts on the following page show how the impedance of co-axial and parallel-wire lines varies with the dimensions and spacing of the conductors.

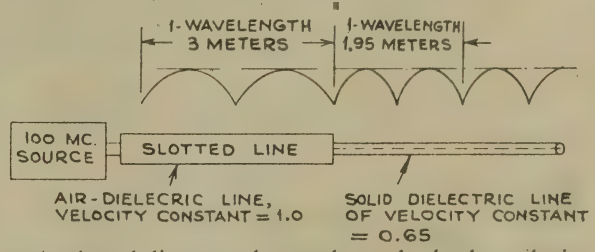
VELOCITY CONSTANT OF LINES

Radio waves travel at a speed of 300 million meters per second in air. The speed is reduced in lines that have spacing insulators or solid di-electric. In a slotted measuring line, with no spacing insulators, the speed is essentially the same as in air.

The speed in solid dielectric lines of high quality such as U.H.F. aircraft antenna cable is about 60-70 per cent. of speed in air. Reels of such cable are tagged with the measured velocity constant of a sample cut from the reel.

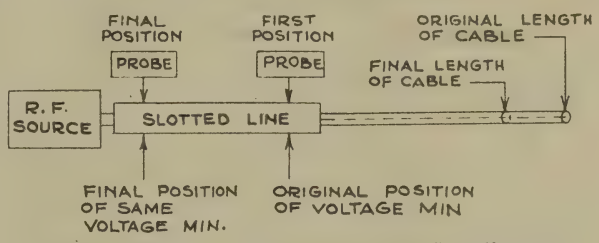
The fact that the velocity is less in the cable than in air means that a wavelength in the cable will be shorter than in air; since the wavelength equals velocity divided by frequency. For example, a wavelength in air at 100 mc/sec. is 3 meters, but in a solid dielectric cable with a velocity constant of 65 per cent., a wavelength at 100 mc/sec. is only 3 x .65, or 1.95 meters.

The lower velocity in solid-dielectric lines is illustrated below. A 100 mc/sec. signal is fed through a slotted line (air dielectric) and into a solid dielectric line that has a velocity constant of 0.65 (65 per cent. of that in air).


1-WAVELENGTH 3 METERS
1-WAVELENGTH 1.95 METERS
100 MC. SOURCE
SLOTTED LINE
AIR-DIELECRIC LINE, VELOCITY CONSTANT = 1.0
SOLID DIELECTRIC LINE OF VELOCITY CONSTANT = 0.65

A slotted line can be used to check the velocity constant of a co-ax cable.

The equipment is set up as shown:



The end of the cable is left open. Standing waves are therefore set up along the cable and slotted line. The probe is set accurately at the first point of minimum voltage at the cable side of slotted line. A piece of cable is cut off at the end of the line. This shifts the voltage minimum point to the left, and the probe is reset accurately to the new position of the voltage minimum.

The ratio of the length of the piece of cable cut off to the distance that the probe is moved is the velocity constant of the cable. (In practice, small increments of cable are cut off until nearly the entire length of the slotted line has been traversed by the probe. Each step is plotted, and the slope of the line indicates the velocity constant.)

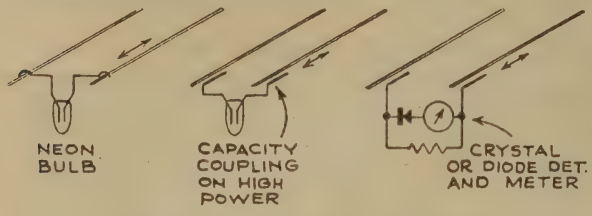
As an example, if the length of cable cut-off is 1 foot, and the probe has been moved 2 feet, the velocity constant is .5, or 50 per cent.

STANDING-WAVE INDICATORS FOR OPEN-WIRE LINES

A small neon bulb may be used to show existence of standing-waves on open-wire lines. If the line is correctly terminated (no standing-waves) the bulb

will have constant brilliance as it is moved along the line.

Better indication can be obtained by using a crystal or diode rectifier and a meter, capacitively coupled to the line as shown.



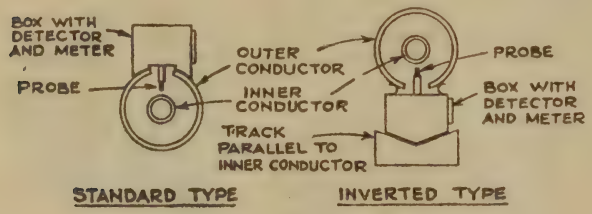
SLOTTED MEASURING LINE

A "slotted line" is a section of co-axial line with a slot along the outer tube to permit loosely coupling an R.F. voltmeter probe to the inner conductor.

The slotted line is used to determine:

(1) Ratio of voltage at maximum and minimum voltage points of standing-waves along the line.
(2) Position of these points with respect to a "Reference" point.

From this data it is possible to determine the resistive and reactive nature of a load at a specified frequency.



Some Principal Applications are:

(1) To adjust antennas for correct match to a line at a specified frequency.
(2) To determine the resistive and reactive components of a load at a specified frequency, or over a range of frequencies—i.e., impedance and phase angle.
(3) To adjust input systems of receivers, dummy loads, etc., for correct match to a line.

Considerable care is taken in the design and construction of slotted lines to secure:

(1) Uniform impedance throughout the length.
(2) Uniform spacing of the probe in its travel along the inner conductor.
(3) Good grounding of the probe box to the outer conductor.
(4) Rigidity of the co-ax assembly, and minimum slop in travel of the voltmeter probe.

The impedance of the slotted line should equal the impedance of the associated co-ax line. Some slotted lines are equipped with two or more mechanically interchangeable inner conductors of different diameters, so the impedance can be changed to match the impedance of commonly used co-ax lines (70 and 50 ohms, and some 63 and 40 ohms).

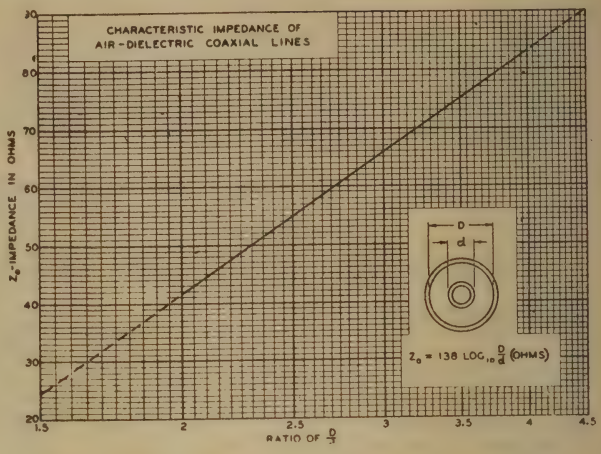
The R.F. voltmeter used in conjunction with the slotted line is usually a diode or crystal detector with a current meter and tuned input, capacitively coupled to the inner conductor.

Diode and crystal detectors are insensitive and require a high output U.H.F. oscillator to excite the line. It is sometimes possible to use the U.H.F. receiver (from an equipment) as an indicator, fitting the input of the receiver with a suitable probe. In this case, owing to the high sensitivity of the receiver, a low-powered U.H.F. generator may be used for the source.

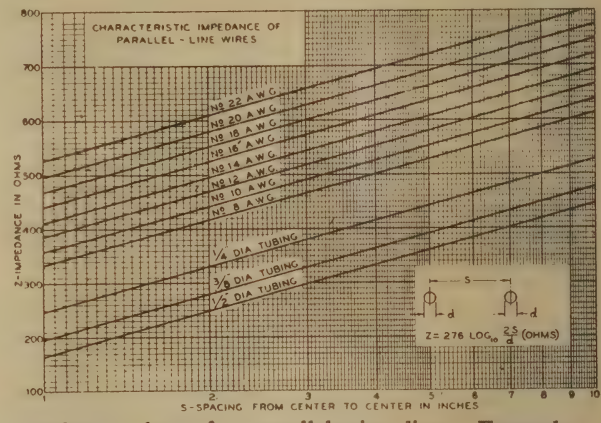
When adjusting antennas, the object in most cases is to "match" the antenna to the line. This is usually done by changing the antenna length and/or the antenna matching stub for **minimum** standing-wave ratio.

For some antennas, and in other applications of the slotted line, it is necessary to determine the resistive and reactive components and phase angle.

This requires checking both the standing-wave ratio and the distance from a minimum (or maximum) voltage point with respect to a "reference" point. This subject is covered in the appendix.

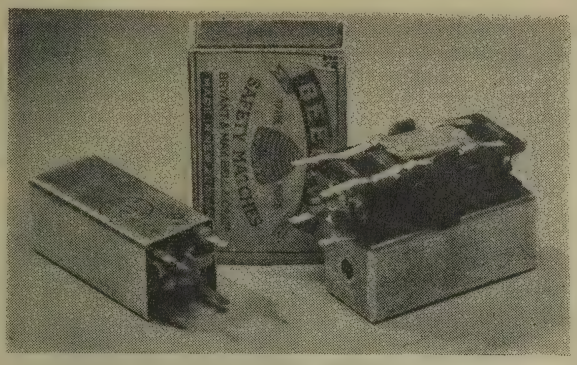

CHARACTERISTIC IMPEDANCE OF AIR-DIELECTRIC COAXIAL LINES
Z_o - IMPEDANCE IN OHMS
RATIO OF $\frac{D}{d}$
$Z_o = 138 \log_{10} \frac{D}{d}$ (OHMS)

Impedance chart for air-dielectric co-axial lines. Example: For a 50-ohm line, "D" is 2.3 times larger than "d"; for a 70-ohm line, "D" is 3.2 times larger than "d."



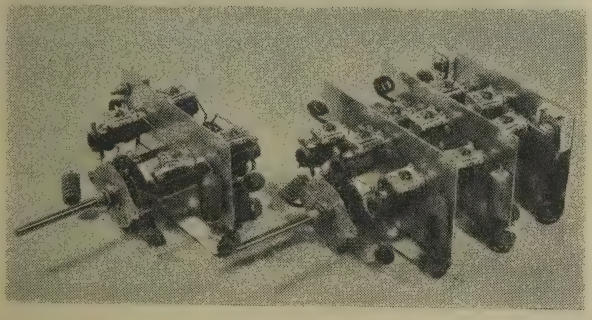
Impedance chart for parallel-wire lines. Example: To obtain a line impedance of 500 ohms, using No. 14 wire, the spacing (S) must be approximately 2 inches.

Where Space is limited—
'WEARITE' I.F. TRANSFORMERS ARE THE LOGICAL CHOICE



"Wearite" I.F.'s are really small—they are only 1 13-16 in. x 13/16 in. — and they are for use where space is very limited. The transformer has enclosed dust cores and is permeability tuned by means of screws which protrude from the top and the bottom of the screening can. Fixed tuning condensers are incorporated inside each unit.
The frequency range is 450 k.c. to 475 k.c. and the Q is exceptionally high to a transformer of this size.

'ARNRITE' QUALITY PRODUCTS



R.F. AND I.F. COILS

The range of Arnrite R.F. and I.F. coils is sufficient to cover all the demands of radio construction. Aerial, R.F. and oscillator air-core coils are available unshielded or shielded, similarly the dual-wave coils are obtainable in these types.

Triple-wave coils, in which the broadcast, intermediate and short-wave coils are assembled in one $3\frac{1}{8}$ in. by $1\frac{5}{8}$ in. can are available in aerial, oscillator and R.F. sections. Shielded broadcast coils permeability tuned are also available.

I.F. transformers, Litz-wound and mounted in $1\frac{3}{8}$ in. by $3\frac{1}{8}$ in. cans are manufactured in the following sizes: 465 k/c. iron core, 465 k/c. air core, 175 k/c air core, and 250 k/c air core.

COIL ASSEMBLIES

Arnrite coil assemblies are available in a comprehensive range. The assemblies are completely wired and it is merely a matter of making the tube and voltage connections, thus eliminating the complex wave-change switch wiring. The assemblies include the coils, switch, trimmers, padders and by-pass condensers.
The Arnrite assemblies are available in Dual Wave (aerial and oscillator sections), Dual Wave (aerial, R.F. and oscillator sections), and Triple Wave (aerial, R.F. and oscillator sections).
Band coverage:

Broadcast	540	to 1800	k/c.
Intermediate	1.8	to 6.0	m/c.
Short-wave	6.0	to 20.0	m/c.

DIALS

Dials, accurately calibrated to function with Arnrite coils and "Polar" gangs, are mechanically rugged and are of the slide rule type with edge lighting. The following types are obtainable: Broadcast, Dual Wave, and Triple Wave.

OBTAINABLE FROM ALL RADIO DEALERS

Wholesale Distributors: ARNOLD AND WRIGHT LTD., Auckland, Wellington, Christchurch

THE PHILIPS EXPERIMENTER

No. 1: AN EL37 30-WATT MODULATOR

Until the recent introduction of the Philips Miniwatt EL37 power pentode, audio outputs of 30 watts or so were rather awkward values for the amateur transmitter to obtain. This state of affairs was due solely to the fact that this figure is too large to achieve easily with the average run of large receiving tubes, and yet too small to obtain economically by using medium-sized transmitting tubes in class B.

SUITABILITY OF THE EL37

Although the EL37 is capable of up to 70 watts output from a pair in Class AB_1 with only a 400-volt power supply, it is admirably suited for operation with reduced rating for power outputs down to 25 watts for the pair, so that this tube appears to be the answer to a long-felt need for a valve which will produce 30 watts or more without any special difficulty. In fact, the amplifier described here gave us the most easily constructed 30-watt amplifier we have yet come across.

TUBE LINE-UP AND CIRCUIT CONSIDERATIONS

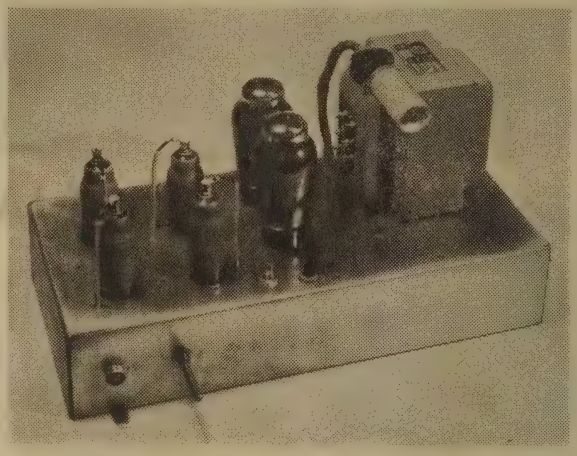
The published data on EL37's in Class AB_1 (see "Radio and Electronics," September, 1946) states that an output of over 30 watts may be obtained under self-bias conditions with a total distortion of just under 4½ per cent. Since, for speech modulation purposes, this degree of distortion can be tolerated readily, it was decided not to use negative feedback, and thus obviate the numerous possible "bugs," and at the same time simplify the construction and tube line-up. The H.T. required is only 325 volts, and the driving signal for full output is 30.5 volts peak at each EL37 grid.

This can be provided easily by the well-known cathode follower type of phase inverter, which gives good balance and low distortion.

In order to allow operation from any commonly-used type of low-level microphone, two stages of voltage amplification are required. For these stages, the logical choice was the new Philips EF37, which has been specially designed for high-gain audio amplification with very low microphone noise. As a pentode resistance coupled stage, the EF37 is capable of gains up to 175 times, and when connected as a triode it has an amplification factor of 28, a mutual conductance of 2.8 ma./v., and a plate resistance of 10,000 ohms. These figures, together with its special non-microphonic qualities, make it an admirable valve for use in the early stages.

In the present amplifier, the first voltage stage is an EF37, triode connected, with a gain of 25 times. After this comes a second EF37 pentode connected with a gain of 120 times. The gain of the phase inverter is 0.92 times to each EL37 grid, so that the overall voltage gain up to the grids of the output stage is $0.92 \times 120 \times 25 = 2760$ times. Since the peak grid signal for each EL37 is 30.5 volts, the input voltage for full output with the gain control at maximum is 0.011v. peak, which provides ample gain for almost any microphone that is likely to be used. Incidentally, the choice of tube type for the phase inverter stage is not critical, but another EF37 has been used here, as it is always an advantage to reduce the total number of types used in a piece of equipment.

It is more usual practice to place the high-gain stage before the low-gain one in a two-stage voltage amplifier, but the normal practice was reversed here for a very good reason. No one always confines himself rigidly to the use of one particular microphone,



and, in addition, constructors are likely to wish to use quite a variety of microphone types, each according to what he has available. Consequently, putting the triode stage first allows a wider range of input voltages to be handled without overloading the first stage.

THE VOLUME INDICATOR CIRCUIT

This is a very useful addition to any modulator or P.A. amplifier, especially one which does not employ an expensive milliameter and which gives two indication levels simultaneously. The secret of this feature is the use of the EM4 magic eye tube, which has two shadows, each with its own sensitivity. This is achieved in the tube itself by having two control electrodes instead of one, each being electrically connected to its own plate in the control triode. One section of the latter's grid has a sharp cut-off characteristic, and the other, a remote cut-off characteristic. Each part of the grid has its own plate, aforementioned, so that one shadow closes with only a small control voltage, while the other does not close fully until a much higher control voltage is provided. In the external circuit, each triode plate is given its own load resistor, so that further control of the relative sensitivities of the two shadows is attained by adjusting the value of the load resistors.

The volume indicator circuit as a whole consists of an EBC33, connected as a straightforward R-C amplifier, and fed from the cathode of the EF37 phase inverter. The diode section is fed from the plate of the triode, and rectifies the resulting audio signal,

producing a negative D.C. potential which is proportional at all times to the signal level in the amplifier. This is filtered and applied directly to the grid of the EM34. It will be noted that there is a potentiometer provided at the input to the EBC33. The object of this is to enable the level at which the eye closes to be adjusted to any convenient value. Normally, of course, this level will be that of maximum output, so that the only adjustment necessary is to turn the volume indicator input control so that the less sensitive shadow just closes when the transmitter is being fully modulated, or when the maximum required output is reached. When this is done, the sensitive shadow will close at approximately 50 per cent. of the power output represented by full closure of the other shadow.

In this way, the volume indicator enables any desired power output to be indicated, as when the amplifier is only required to modulate a low-power transmitter, or to fully load a small loudspeaker. The sensitive shadow may be used to indicate that modulation depths **below** the level indicated by it should not be allowed to occur. Thus, the two shadows indicate minimum and maximum power output for good quality, high-level modulation.

CONSTRUCTIONAL POINTS

No special precautions are necessary in getting the amplifier to go properly, other than to lay the parts out in a straightforward manner as indicated by the photograph. The left-hand front tube is the input stage. The one behind it is the EF37 pentode stage, and the one to the right of this is the phase inverter. The remaining tube, apart from the EL37's, is the EBC33. The EM34 is mounted with some length of lead on an ordinary octal socket so that it can be placed on the front panel for viewing. The panel was omitted in the photograph so as to give a clearer view of the whole amplifier. With the tubes well spread out, as in the photograph (the small valves are at the corners of a 2¾ in. square), there is ample room underneath to allow the small parts to be wired in directly to the socket pins without overcrowding.

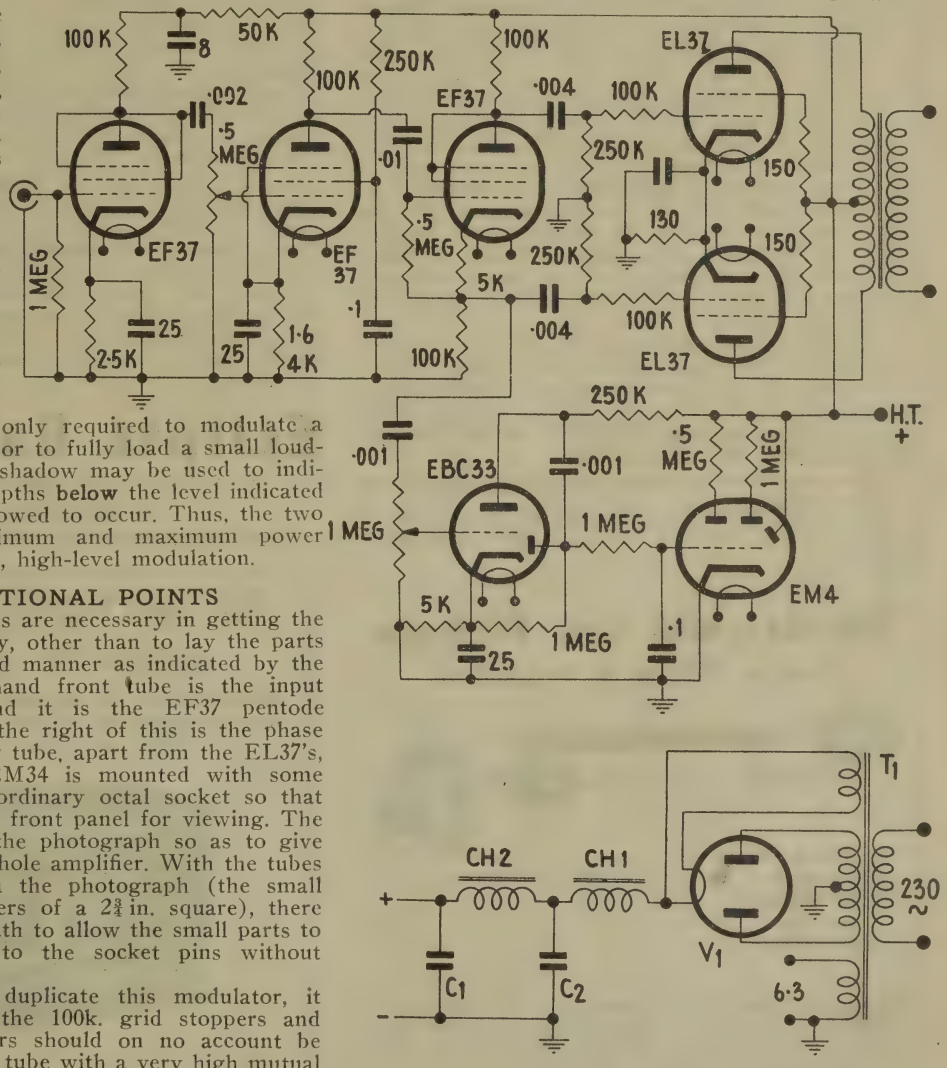
If it is desired to duplicate this modulator, it should be noted that the 100k. grid stoppers and 150-ohm screen stoppers should on no account be omitted. The EL37 is a tube with a very high mutual conductance, and if these parasitic suppressors are omitted, endless trouble and no little disappointment may be caused. With them in, however, the amplifier is perfectly stable, and can be relied upon to work properly at first switching-on.

OUTPUT MATCHING

The output transformer shown in the photograph is a stock model of 50-watt modulation transformer with a wide range of available impedances. The correct load for the EL37's is 4000 ohms plate-to-plate.

FREQUENCY RESPONSE

Since this amplifier was designed particularly as a modulator, the low-frequency response has been purposely attenuated below 200 c/sec. A frequency run showed that the response was 6 db. down at 100 c/sec., with only 3 db. loss at 200 c/sec., and a quite sharp drop from 100 c/sec. down. If the amplifier is required for other purposes and better low-frequency response is wanted, it may be obtained simply by increasing the value of the coupling con-



C_1, C_2 = 16 mfd. 450v. electro.
For other power supply items, see text.

densers at the grids of the EL37's and the second EF37 to 0.1 mfd.

POWER SUPPLY

In obtaining the rated output from a pair of EL37's, the characteristics of the power supply are quite important. Under 325-volt conditions, the D.C. plate and screen currents total 173.5 ma. with no

signal, and 240 ma. at maximum output. This represents an appreciable variation, so that quite good regulation is required of the power supply. However, since the no-signal current is quite high, no difficulty should be experienced in achieving good enough regulation for the amplifier to give its rated power output quite readily.

Choke input and a mercury vapour rectifier are essential, together with low-resistance windings in the smoothing chokes and power transformer. Assuming a power transformer T_1 in which each half of the secondary has a resistance of 100 ohms, a mercury vapour rectifier, and smoothing chokes of 100 ohms each, then the drop in H.T. voltage at full output would be 18 volts compared with the no signal H.T. voltage. This gives a regulation of 5½ per cent., which is quite good enough for the purpose in hand.

With the above amounts of series resistances in the power supply, a transformer of 385-0-385v.-a-side will be sufficient. A current rating of 200 ma. continuous running will be ample, since the full current of 240 ma. is taken only on peaks. In ordering transformer and chokes, the resistances of these components should be specified as not greater than the figures given above.

In response to many requests, we have pleasure in announcing that the "Philips Experimenter No. 2" will contain a description of how to go about obtaining the full rated output of 70 watts from a pair of EL37's.—**Inserted by PHILIPS ELECTRICAL INDUSTRIES OF N.Z., LTD.**

Did you know that there are more Rola speakers in use in New Zealand than all other makes put together?

The Original Coil Pick-up

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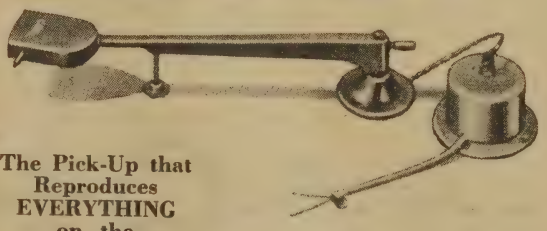

The Pick-Up that Reproduces EVERYTHING on the RECORD.

DATA:

Frequency Response: Flat within 3-db. from 30-c.p.s. to 9000-c.p.s. Frequency Limits: 5-c.p.s. to 15,000-c.p.s. Output: 35-db. below 1v. R.M.S.—0.03v. average. Coil Impedance: 5 ohms. Output Impedance: 100,000 ohms. Needle Pressure: Adjustable from ¼ oz. to 1 oz.—½ oz. is a good average. Needle Type: "Silent Stylus," "99" or equivalent. Finish: Dark Bronze. Other Finishes to order. The Pick-Up is supplied complete with coupling transformer and equalizer in a screened case. An arm rest, all fixing screws and complete instructions for mounting are included.

PRICE: Complete with Equalizer - - Retail £10/-/-

Can be supplied with Scratch Filter 69/6 extra.

Sole Distributor:

MILES NELSON

Box 245, Auckland

Bargains in Bits and Pieces...

Burlington 0-1 ma. D.C.	£2/9/-
5-valve A.C. Broadcast Kit Sets complete to the last nut and bolt	£12/10/-
Aluminium Sheet 1/16 in. gauge, 6 in. x 6 in.	2/-
" " " 12 in. x 6 in.	4/-
" " " 12 in. x 12 in.	8/-
Solon Soldering Irons	29/6
Webster Automatic Record Changers	£19/19/6
Vibrators (brand new), 12 volt, 7 pin	3/6
Reduction Drives, ¾ in. to ¼ in.	4/6
2-gang 450 variable condensers	13/6
4 mfd. 450 V.D.C. Electrolytic Condensers	2/6
2-valve Cadmium Plated Chassis	5/6
3-valve Cadmium Plated Chassis	7/6
5 and 6 valve Cadmium Plated Chassis	12/6
Speakers!	3 in., £1; 12 in., £10
6K8-GT Valves (new)	6/6

Now, chaps, how about a present for Mum? We have a complete selection of Electric Jugs from 35/-, Toasters 35/-, Immersion Water Heaters from 12/6. Eclipse Radio Ltd. offer you a complete range of radio components, both transmitting and receiving. Write and get a quotation from us. You will not regret it.

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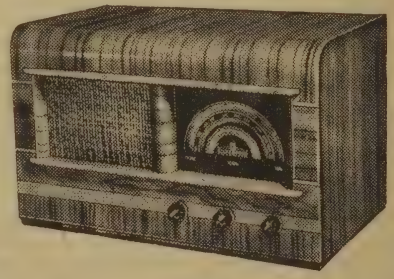
SILVERTONE RADIOS

AGENTS WANTED

Silvertone is an established make which has been successfully sold in Auckland for many years by S. E. Moe Co., Ltd.



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(Successors to S. E. Moe Co., Ltd.) are extending the distribution of the now famous Silvertone, and invite inquiries from reputable firms with progressive sales policies. A full range of models is available. Further information will be sent on request. Apply to

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A Practical Beginners' Course

PART 15

In the last instalment we saw what alternating currents are, and how a radio frequency carrier is modulated by the audio frequency currents derived from the microphone. We are now in a position to describe how crystal and diode detectors function in regaining the audio frequency signal from the modulated carrier.

In the first place, it would seem that passing the radio frequency currents from the aerial through the headphones would cause the audio frequency variations in amplitude to make the diaphragms of the headphones vibrate and reproduce the original sounds. However, a little consideration will show that this is not possible.

Remembering the nature of alternating currents, it is clear that on one half of the radio frequency cycle, the diaphragm of the headphone will be pulled toward the magnet. On the other half of the cycle, however, the current flows in the opposite direction, and will therefore push the diaphragm further from the magnet. But the radio frequency current (R.F. for short) alternates at such a high rate that the individual pulls and pushes on the diaphragm last only a millionth of a second or even less, and this time is so short that before the diaphragm has had time to move in response to a pull, a push comes along and tries to reverse the direction of motion of the diaphragm. The net result is that the diaphragm does not move at all, and no sound is heard from the headphone.

At audio frequencies, however, the diaphragm is able to respond to the push-pull action of the current through the coils, so that the diaphragm vibrates and makes a sound.

Now, suppose we have a device which is able to pass currents in one direction only. When the headphones are placed in series with this instrument, and the R.F. is applied to the combination, we have a somewhat different situation. When the alternating current tries to flow in one direction through this circuit, it cannot, so that there is no current through the headphone coils, and no pull or push on the diaphragm. When the current tries to flow in the opposite direction, as it does every other half cycle, our new device allows it to pass, thus producing a pull (or a push) on the diaphragm. Thus the reverse movement does not tend to occur, and all pushes or pulls on the diaphragm are in the same direction. If the amplitude of the R.F. current is steady (i.e., does not vary) then all that will result will be a steady pull on the diaphragm. But if the R.F. is modulated, the pull will also vary, but at a rate determined by the modulation frequency. Since this is an audio frequency, the 'phones are able to respond to this variation in pull, and movement of the diaphragm will result, also at the rate of the audio modulation frequency. Thus, we have the diaphragm vibrating and producing a sound corresponding in frequency to the modulation frequency.

The device we have been talking about, which allows current to flow in only one direction through it, is called a **rectifier.** A crystal detector is such a device, and so, it will be remembered, is a diode valve. This is why our first valve sets used a diode to directly replace the crystal, the circuit remaining unchanged in other respects.

SOME NEW VALVE CIRCUITS

At this point we can become practical again and consider some new single valve circuits. This time we will not use the valve as a diode, but as a triode. The first circuit is shown in Fig. 26, which may be compared with the circuit in Fig. 21. Now, instead of connecting the grid and plate together and using the valve as a diode in series with the headphones, we connect the filament to the earthed end of the

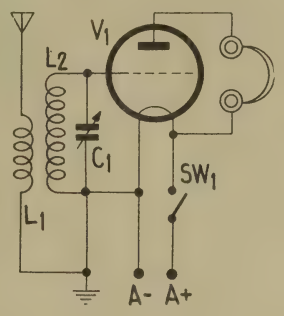


Fig. 26

tuned circuit, and the grid to the other end, at which the R.F. voltages appear. Now, the headphones are connected to the plate of the valve, and to the positive side of the filament, or A +.

If you go back a few instalments to where we were discussing the way in which electrons are emitted by the filament and attracted towards the plate, being controlled on the way by a small voltage on the grid, this new circuit will become quite clear.

For instance, the circuit must be connected as shown, with the negative battery terminal, A —, connected to earth, and the positive terminal through the switch to the filament and headphones. This is because connecting in this way places a very small voltage on the plate of the valve—sufficient to allow it to function after a fashion. If the battery terminals are reversed, the filament will still heat as before, but there will be a small negative voltage on the plate, so that the valve will stop conducting, and nothing will be heard in the 'phones.

This circuit is really a very primitive type of amplifier and detector combined. The grid can be imagined as the plate of a diode, for when the R.F. grid voltage is on its positive half-cycle, current will flow in the grid circuit, but when the negative R.F. half-cycle comes along, electrons are repelled from the grid and no current flows in the grid circuit. Thus, the grid rectifies the alternating current just as a crystal or a diode does. At the same time as this action is going on, a small current is flowing in the plate circuit, because of the small positive voltage applied to the plate from the positive end of the filament. Because the grid controls the flow of plate current, the audio frequency's variations of voltage at the grid cause similar, but larger, variations in the plate current. Thus, with the headphones in series with the plate circuit, an amplified audio voltage is produced across them and is heard as a somewhat louder signal than would be given by the circuit of Fig. 21.

We would like to emphasize that Fig. 26 is not presented as a very useful circuit, since in some cases,

depending on the valve used, the sensitivity will not be any greater than that of the straight diode circuit. It is useful in showing how the next circuit, Fig. 27, evolves from the diode detector. Fig. 27 differs from Fig. 26 in two particulars only. The first of these is the inclusion of C_2 and R_1 in parallel. These components are really necessary to make the grid function properly as a diode detector. The other difference is the use of a separate battery for the plate circuit. As previously explained, this is called the "B" battery to distinguish it from the filament or "A" battery. The negative terminal of both batteries are connected together and to the earthed side of the set, and the positive terminal of the "B" battery is connected to one tag of the headphones as shown in the circuit.

SIZE OF THE "B" BATTERY

For the circuit of Fig. 27, a "B" battery of 45 volts can be used, if the greatest possible sensitivity is desired, but the circuit will work well with as little as 10 volts of "B" battery. This is a help to those who find the price of a proper 45-volt battery too high for them. To get very good results three flat torch batteries connected in series giving a total of 13½ volts will be plenty, and will last quite a long time owing to the small current drawn by the valve.

VALUES OF C_2 AND R_1

The values of these components are not at all critical. For a set working on the broadcast band (we will leave the short-wave question till later) C_2 can be 0.00025 mfd. and R_1 can be 2 to 4 megohms. A little juggling with the value of R_1 will show what value gives the best results. If you buy three resistors one each of 1, 2 and 3 megohms, then you can insert any value simply by using one of the resistors or any combination of two in series.

POSITION OF THE SWITCH

It will be seen that the switch has been placed only in the A + lead, so that even when the set is switched

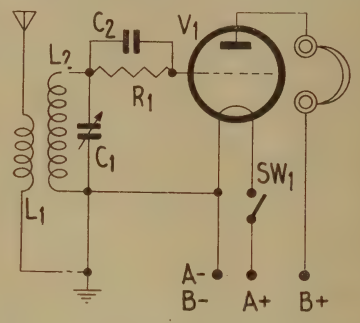


Fig. 27

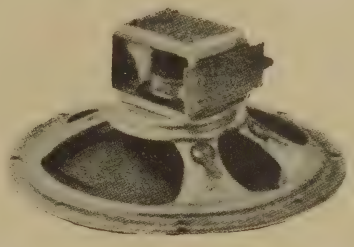
off, the "B" battery is still connected. This is quite in order, since if the filament of the valve is not heated, no current can flow in the plate circuit, and the "B" battery will not run down.

USING OTHER TUNING CIRCUITS

In Figs. 26 and 27, the tuning arrangements are shown as a simple untapped aerial coil and an untapped tuned circuit. This has been done purely for the sake of simplicity, but there is no reason why any of the more complex tuning circuits that were used in our crystal sets should not also be used with these

(Continued on page 48.)

SENSATIONAL VALUE! ANOTHER SMASHING BARGAIN FROM NEW ZEALAND'S LEADING RADIO HOUSE



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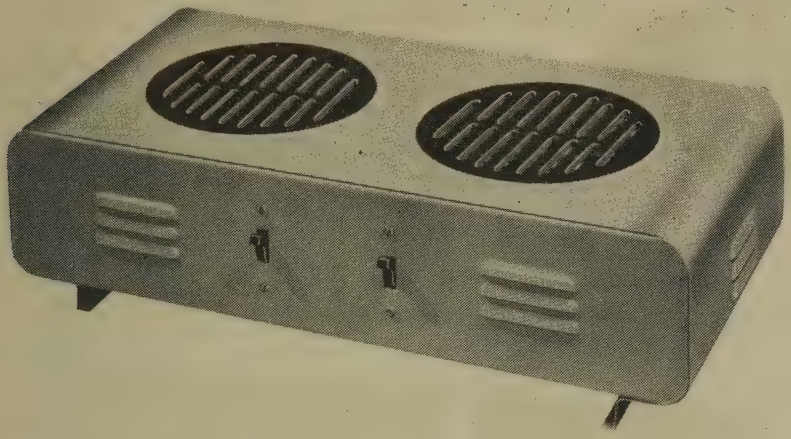

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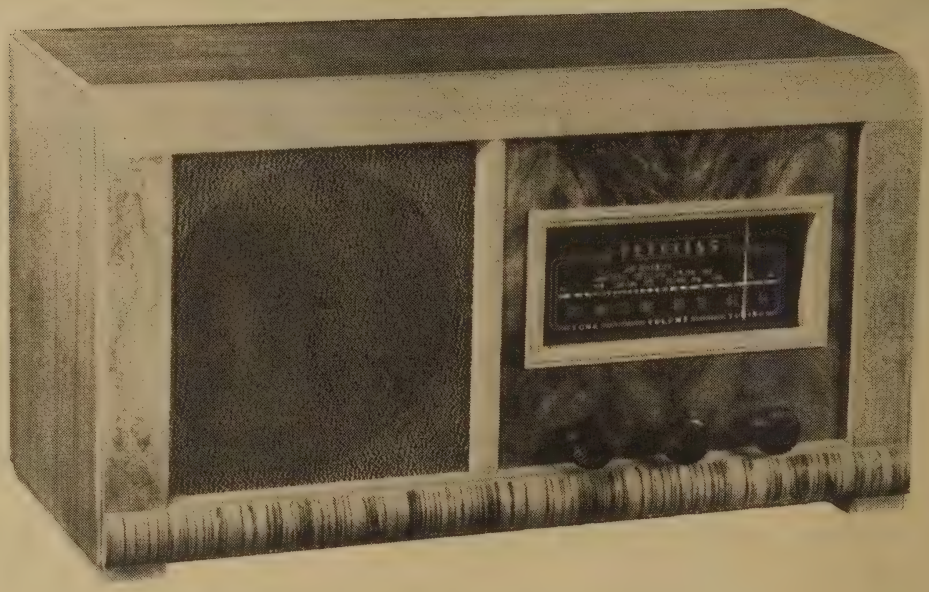

A high class Radio, made of the best components and built to give true reproduction. Five-valve 465 kc. Superheterodyne receiver, employing one each 6K7GT, 6K8GT, 6Q7GT, 6V6GT and 5Y3GT valves, and operating on the standard New Zealand supply of 230 volts and 50 cycles.

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NEW PRODUCTS: LATEST RELEASES IN ELECTRONIC EQUIPMENT

THE EDDYSTONE "640" RECEIVER

Eddystone take great pleasure in announcing the "640" communications receiver, which is the first British receiver to be really designed, in the true sense of the word, for amateur use.

The Eddystone "640" is not merely a compromise between an ordinary short-wave receiver of no particular merit and the full communications specification, but is a radical departure from these notions. It has been designed by engineers for good amateur band working as the prime consideration. It is fitted, therefore, with a properly arranged electrical band spread, a crystal gate, noise limiter, and stand-by switch. The valve line is right up to the best ideas in the field of circuit design.

General Performance

The "640" is a 9-valve receiver with one tuned R.F. stage, F.C., two I.F. stages, detector—A.V.C.—1st audio, 2nd audio output, noise limiter, B.F.O. and rectifier. The tubes used in that order are EF39, 6K8, EF39, EF39, 6Q7, 6V6, EB34, EF39 and 6X5.

The R.F. stage gives high gain with low noise. The I.F. frequency is 1.6 mc/sec., with the crystal filter in the first stage. The crystal is vacuum mounted for high Q and, with proper operation, an adjacent channel attenuation of about 45 db. can be obtained, with little loss of strength of the signal on tune.

The series noise limiter can be switched from the front panel, and has been arranged to give a minimum signal loss when in action.

The audio output is 3 watts, and is arranged for a 2.5-ohm speaker or H.R. headphones. The stand-by switch cuts H.F. to the receiver on "transmit," and can be used to operate the transmitting change-over relay for which connections are provided on the rear panel.

An ingenious arrangement of the drive motions produces band-set and band-spread on the same dial. Two sets of parallel three-gangs—band-spread and band-set—are used, driving concentrically mounted scale pointers—one for band-set and one for band-spread.

The tuning range of the "640" is 1700 kc/sec. to 31 mc/cs. continuous, obtained in three slightly overlapping bands.

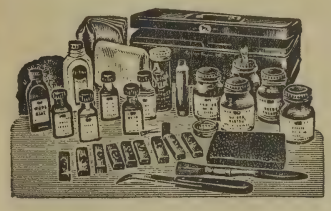
The overall sensitivity of the receiver is 2 microvolts in for 50 milli-volts out. The crystal-out selectivity curve gives a drop of about 25 db. at 10 kc/sec. off resonance. With crystal-in a very high degree of selectivity may be obtained.

Image ratios vary from 45 db. down at 30 mc/sec. to about 100 lb. down at 1.8 mc/sec. No S meter is fitted to the receiver, but a socket is provided into which a meter may be connected in the usual way.

The tuning unit is on a heavy aluminium casting; the power unit and other units being of plated brass. The cabinet is of heavy rust-proofed steel finished in a fine rippled black. The signal circuits have iron-dust cores and are air trimmed. The I.F. transformers are permeability tuned as is the B.F.O. coil.

* * *

RADIO CHEMICAL LABORATORY



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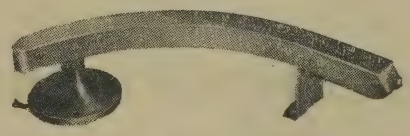
Further information is available from the New Zealand agents, Messrs. Swan Electric Co., Ltd., Wellington, Auckland and Christchurch.

* * *

B.T.H. PEZOLECTRIC PICK-UP



Making a welcome post-war re-appearance the B.T.H. Pezolectric Pick-up is now available from the sole New Zealand agents, The National Electrical & Engineering Co., Ltd. (NEECO), 286-288 Wakefield Street, Wellington.

In reproducing modern high fidelity recordings a pick-up is needed having a wide range frequency characteristic. Very often a pick-up with a good high-frequency response is lacking in bass, but the B.T.H. Pezolectric has a generously rising bass response which compensates for low frequency attenuation below 200 c.p.s. both in records and in amplifier circuits.

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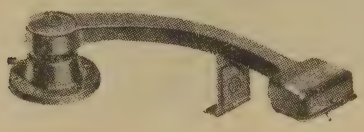
Characteristics: Output at 1000 c.p.s., 1.7 volts R.M.S.; impedance 1000 c.p.s., 160,000 ohms; capacitv (approx.), .001 μf.

The B.T.H. Magnetic Pick-up

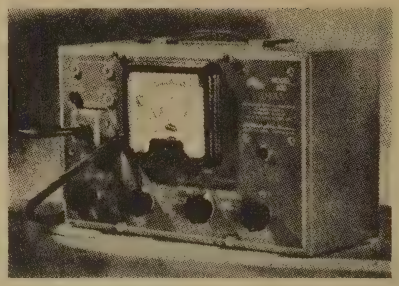


National Electric recently landed a number of the well-known B.T.H. Magnetic Pick-ups, but stocks are now exhausted. Further supplies are, however, expected very soon.

* * *

McMURDO SILVER INSTRUMENTS

The basic instrument required in any laboratory or service shop is the volt-ohm-milliammeter. If modern receivers and electronic apparatus are to be serviced effectively and efficiently, it is imperative that the meter used has a high input resistance in order to measure, without error, almost currentless voltages in high resistance receiver circuits. Only with a V.T.V.M. can grid, screen and plate voltages be read at the tube socket, and only with a V.T.V.M.



can the frequency range be made so great that A.F., I.F. and R.F. signal voltages themselves can be directly read.

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D.C. voltage ranges are: zero to 3, 12, 30, 120, 300 and 1200 volts at 51 megohms input resistance; 7.5, 30, 75, 300, 750 and 3000 volts at 126 megohms meter

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input resistance. All ranges available in reverse polarity. A.C. voltage ranges are: 3.12, 30, 120, 300 and 1200 volts. Three decibel-output meter ranges cover —10 to +10, +10 to +30 and +30 to +50 db. Six resistance ranges cover zero to 2,000, 20,000, 200,000 ohms and 2, 20 and 2,000 megohms. Six direct current ranges are zero to 1.2, 30, 120, 300 ma. and 1.2 and 12 amperes.

From the comprehensive range of McMurdo Silver test and transmitter equipment the 701 "Atom-X" transmitter is worthy of note. Measuring only 10 in. x 5 in. x 5¼ in., this instrument is a modern six-band transmitter which will take 75 watts input from 3.5 through to 54 megacycles. C.W. power output is a nominal 50 watts for 75 watts final input, to its 807 final amplifier at any amateur frequency and the built-in phone modulator provides 14 watts audio output to 100 per cent. modulated 28 watts final input.

Full information may be obtained from the New Zealand agent, W. G. Leatham, P.O. Box 11, Lower Hutt, Wellington.

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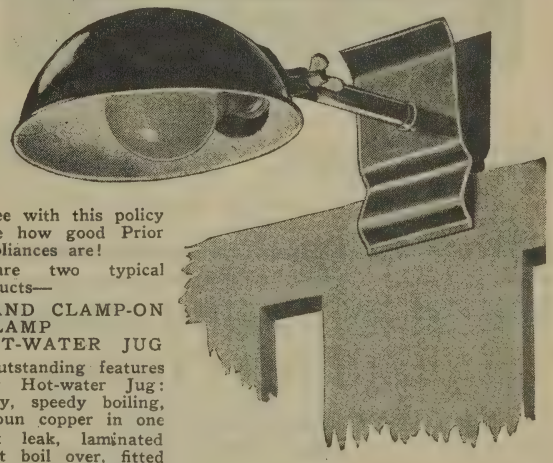

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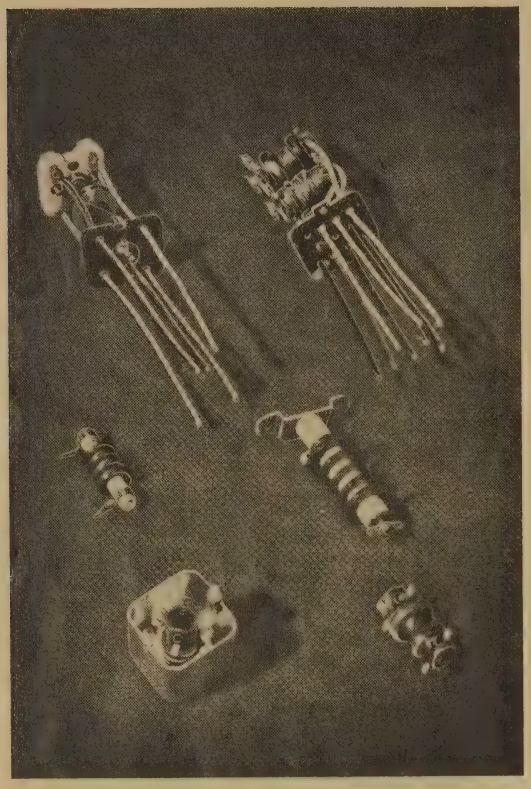

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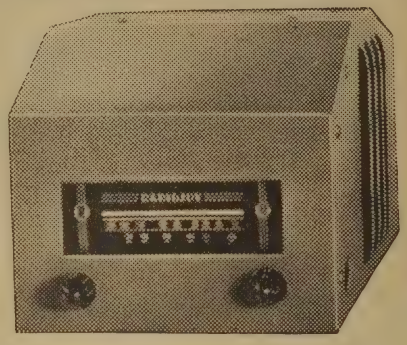

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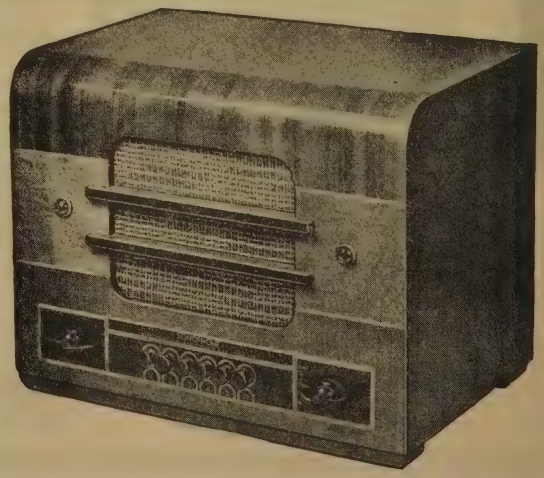


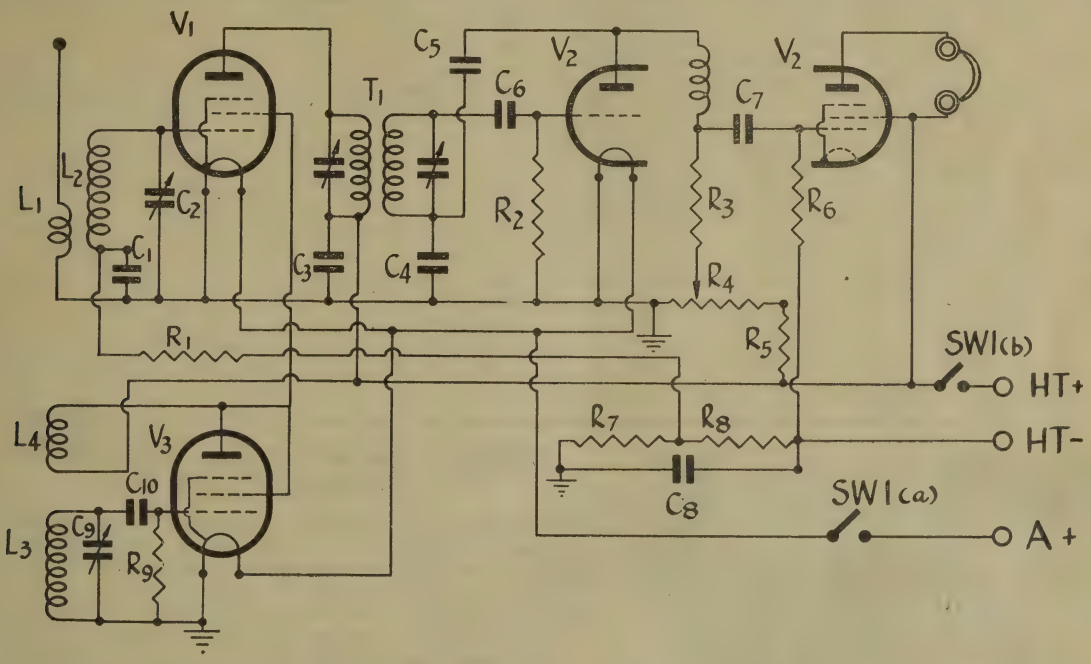
THE BEGINNERS' SUPERHET

This receiver, as its name implies, is designed to give the newcomer to radio some experience with the principle of superheterodyne reception, so that he will have some practical knowledge of the problems involved in building a full-scale A.C. superhet.

PART I

SCOPE OF THE RECEIVER

As stated above, this set is above all an experimental one with which the learner may find out for himself a little about the principles of the superheterodyne, and has no pretensions at all to being a "hot" or sensitive set with great DX capabilities. In fact, it is not nearly as sensitive as the "Progressive Three," which appeared in our pages some months ago and used the same tubes in a T.R.F. circuit. The present set has been designed to use the same tube types as did the "Progressive Three," and the same chassis, so that anyone who has built the former set has most of the parts required to change the set over to this new design.



TUBE LINE-UP AND PRINCIPLE OF OPERATION

V_1 is a 1N5-GT, used as the mixer. V_3 is the local oscillator, using a 1P5-GT, while V_2 is a 1D8-GT, of which the triode section is used as a regenerative second detector, and the pentode section is an audio amplifier stage feeding the headphones.

The mixer, V_1, has a normal kind of aerial coil, L_1L_2, no different from that of a T.R.F. receiver. The aerial winding, L_1, is coupled to the tuned circuit, L_2C_2, which tunes to the frequency of the incoming signal. So far, so good, and everything is quite straightforward. To those unversed in the ways of superhets., the remainder of the V_1 circuit will require a little explanation.

The oscillator, V_3, has its plate connected to the screen of V_1. There is nothing unusual about the circuit of V_3, as it is simply a normal tickler-feedback type of oscillator, tuned by the circuit, L_3C_9. V_3 is connected as a triode by tying the screen to the plate. Because of its connection to the screen of V_1, the output of the oscillator is impressed on the electron stream of V_1 simultaneously with the signal.

Now, when two different frequencies are fed into a valve which is suitably biased, the two original frequencies are not the only ones to appear in the plate circuit of the valve. Owing to the fact that the mixer, as it is called, is biased quite close to cut-off, its produces distortion, with the result that new frequencies appear in its output circuit. Suppose the two frequencies are F_s, the signal frequency, and F_o, the oscillator frequency. The main new frequencies to appear are $(F_o + F_s)$ and $(F_o - F_s)$. To take an example, suppose the signal is on the broadcast band, at 1000 kc/sec., and the oscillator is higher in frequency than this, say, at 1465 kc/sec. Then the mixer plate circuit will have currents in it at four main frequencies, 1000 kc/sec., 1465 kc/sec., 2465 kc/sec., and 465 kc/sec. Obviously, we cannot make use of all these signals simultaneously, nor do we wish to. Instead, we place a tuned transformer in the plate circuit of the mixer. This transformer is labelled T_1 in the circuit diagram and is tuned to 465 kc/sec. By this simple means, the other three components are rejected and the 465 kc/sec. signal is passed on to the next valve.

In this case the next valve is the triode section of the 1D8-GT, which is connected as a regenerative detector. This acts in the usual manner and detects the 465 kc/sec. signal, giving an audio frequency output in its plate circuit. R_4 is the reaction control, by means of which the detector may be controlled, just as is any other regenerative detector.

The beginner may well ask at this point, "Why go to all the bother of using an R.F. oscillator to convert the original 1000 kc/sec. signal to a new frequency (465 kc/sec.) only to detect it at this frequency?"

The answer to this question gives us the whole reason for the popularity of the superhet., and why commercial receivers no longer employ T.R.F. circuits. It is simply this: It is much easier to achieve high gain and selectivity when one is dealing with a low frequency than when the set is handling a high one. Also, it is a very difficult matter to design a set relying only on R.F. amplification at the signal frequency, in such a way that the gain and selectivity are approximately the same over the whole broadcast band. But if all signals are first converted to a fixed frequency, lower than the signal frequency, the problem of uniform gain and selectivity is much easier to solve, and, in addition, much greater selectivity than can ever be obtained with a T.R.F. can easily be achieved.

In our example, we assumed a signal at 1000 kc/sec., an oscillator frequency of 1465 kc/sec., and further that T_1 picked out the difference between these two frequencies, viz., 465 kc/sec. How, then, do we get on if we now want to tune to another station on a different frequency?? Suppose we tune C_2 so that the new station on, say, 700 kc/sec. is applied to the grid of V_1. The frequencies now to be found in the mixer plate circuit are 700 kc/sec., 1465 kc/sec., 2165 kc/sec., and 765 kc/sec. T_1, remember, is still tuned to 465 kc/sec., so that none of the signals from the mixer will be passed on to V_2, and nothing will be heard in the headphones.

But suppose, now, that the oscillator is retuned so that its frequency is 1165 kc/sec. The mixer output frequencies will now be 700, 1165, 1865, and 465 kc/sec., and since T_1 is still tuned to 465 kc/sec., this signal will pass on to the detector and be heard in the output.

Thus, in order to receive the new signal, we must do two things: (1) Tune the mixer grid circuit to 700 kc/sec., and (2) tune the oscillator to 1165 kc/sec.

It will be noted that in each case **the oscillator is tuned to a frequency 465 kc/sec. higher than that of the signal.** Also, the tuning of the set as a whole is controlled not by the frequency to which L_2C_2 is tuned, but by the oscillator frequency. In short, the only signal that can be received is one 465 kc/sec. lower than that of the oscillator. The grid circuit of V_1 could be untuned, yet the circuit would still act as a superhet., because of all the signals that may be present on the grid of V_1 simultaneously, the only one to be heard will be the one that is 465 kc/sec. lower in frequency than the oscillator.

The frequency of 465 kc/sec. which has cropped up so much in this explanation, and to which the transformer T_1 is tuned, is known as the intermediate frequency, or I.F. for short.

In practically all receivers the detector does not immediately follow the I.F. transformer as here.

(Continued on page 44.)

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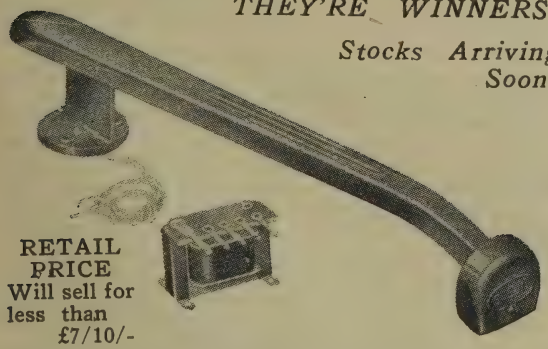

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THE EDITOR'S OPINION

This column, which will be a permanent feature, is the Editor's unbiased opinion of apparatus submitted for inspection or test in our laboratory.

A New Sound System for Schools, etc.

A new sound system notable for its versatility and excellent electronic engineering practice has been installed at the Hataitai School, Wellington, by Messrs. Green and Cooper Ltd.

Showing the neat and accessible lay-out of the equipment.

Designed by Mr. A. McD. Cooper, A.M.Brit.I.R.E., the company's design engineer, the system has many unique features, perhaps the most outstanding of which is the combination of P.A. and inter-communication facilities in one piece of equipment.

The Editor of "Radio and Electronics" was invited to inspect the installation, and was given a demonstration of all its functions by the Headmaster, Mr. Le Petit.

The equipment consists of a normal P.A. system with loud speakers in each of the nine classrooms and a large outside speaker for marching and assembly, with input arrangements embracing either radio, record playing, or microphone. By means of an ingenious switching system, it is possible to disconnect any or all of the speakers from the P.A. amplifier, in such a way that the speaker so disconnected immediately becomes part of a separate inter-communication unit worked from the main operating position. Since inter-communication and P.A. amplifiers are entirely separate, it is possible to communicate with any classroom at the same time as other classrooms are receiving a radio or recorded programme. The sensitivity and clarity of the intercom. is such that teachers, or pupils, can reply to a call in a normal voice from any part of the classroom.

It is obvious that a system of this nature is capable of fulfilling a wide variety of useful purposes in the day-to-day life of the school. Many schools have scattered classrooms but this system enables the headmaster to contact a teacher or pupil from his study. With the present shortage of teaching staff the headmaster can keep an attentive ear on the proceedings of unattended classrooms. As well as the more obvious time-saving uses of the system, it enables a number of entirely new school activities to be carried on. For example, the school conducts a competitive "Quiz" relating to the previous week's work. The "Quiz" is organized similarly to the broadcast programmes on this principle—the "Quiz" mistress and pupils being in front of the main microphone, and the entire school listening to the "broadcast" by means of the speakers in the classrooms. The microphone is also being used to train pupils in voice production.

The radio equipment comprises a broadcast tuner containing R.F., mixer, I.F., diode detector and A.V.C. stages. An additional diode is used as a noise suppressor. The output from the tuner is fed to an audio mixer stage via a change-over switch for radio or pick-up. The microphone pre-amplifier is also connected to the audio mixer, the output of which is fed via a phase inverter to a pair of push-pull 6L6 output tubes. Negative feedback is applied from an output transformer secondary to the phase inverter.

Classroom speakers are replaced by dummy load resistors when they are switched off. The speaker in the master unit is used for monitoring radio or record player, but switching circuits are such that when the system becomes an intercom. the monitor speaker functions as a microphone. Similarly, the classroom speakers are used as microphones when the intercom. facilities are in use.

For intercom. use, a separate amplifier and power supply is used, which utilizes a 6J7, 6V6 and 6X5.

The complete installation reflects great credit on the manufacturers. Although this particular system is used for school purposes, it could be employed in any building, office, factory, or institution where the efficient distribution of sound is indispensable.

Any information with reference to this or any other system of a similar nature, but requiring special design, may be obtained from the designers and manufacturers, Messrs. Green & Cooper Ltd., 43 Lower Taranaki Street, Wellington.

(*continued from page 42*)

There is usually an I.F. amplifier valve which amplifies the 465 kc/sec. signals and passes them to the detector through a second I.F. transformer. This adds one more valve, but does not alter the principle of the set at all.

The valve which detects the I.F. signal is usually called the "second detector." This is really a misnomer, because the signal is only "detected" or separated from the R.F. carrier once in the set, and not twice, as the name would imply. The name has arisen through the practice of calling the mixer the "first detector," because the mechanism of the mixer is similar in one respect to the action of a detector. In English publications the mixer is usually called the "frequency changer," which is really a better name for it. (To be continued.)

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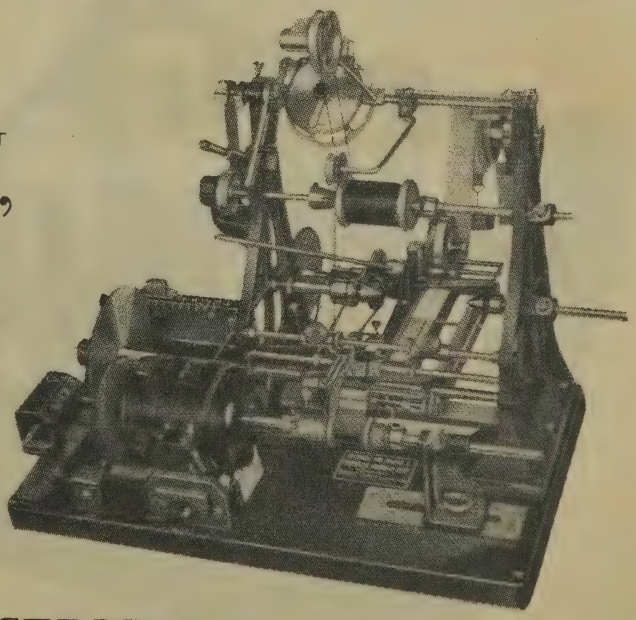

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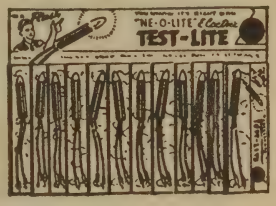

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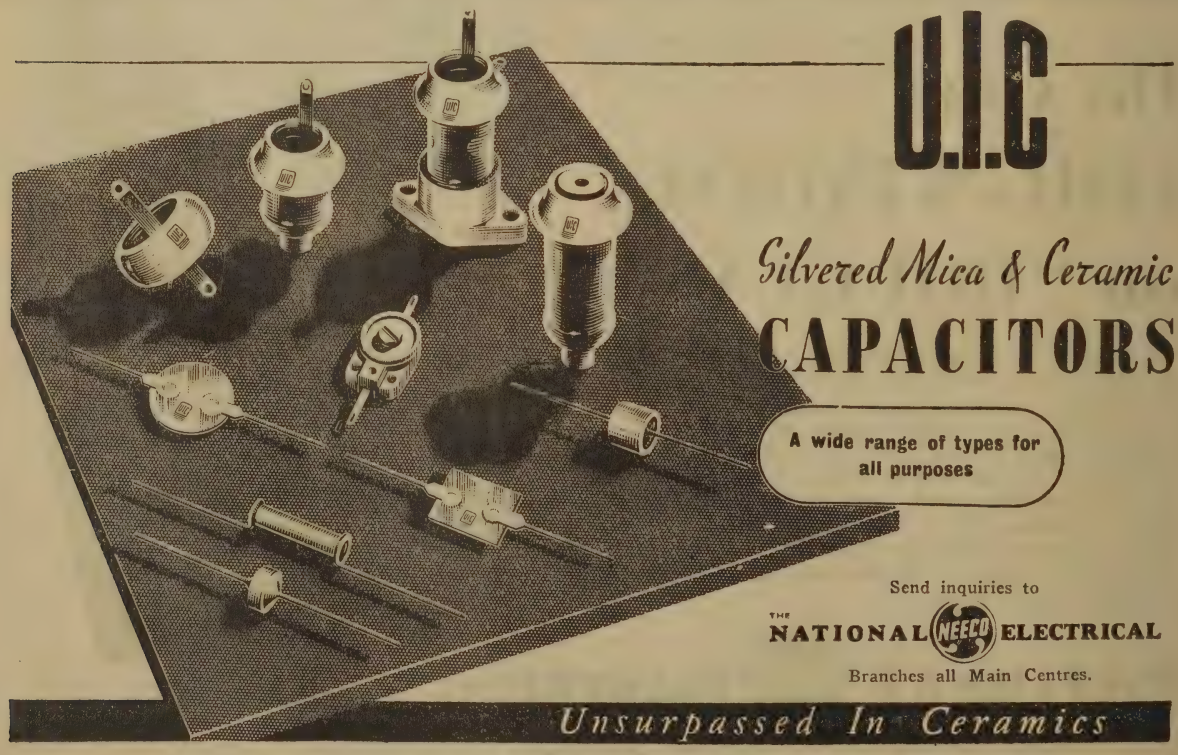
GOSSIP COLUMN

(Continued from page 15.)

Last month, the Branch Managers of Messrs. Turnbull and Jones assembled in Wellington to attend a Conference lasting a week.

Matters affecting future policy were fully discussed, and important decisions were made, as a result of which the Company will be able to offer a greater service and wider range of radio and electrical goods to the trade.

Those who attended the Conference were Messrs. J. M. Fleming, Managing Director, C. J. Lenihan, General Manager, K. R. Port, Secretary, J. C. Pascoe, Auckland, R. R. Hayman, Wellington, S. O. Dillon, Christchurch, and S. F. Chalmers, of Dunedin.



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AIRCRAFT APPROACH SYSTEM

(Continued from page 7.)

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It is expected that air crashes due to poor landing visibility will be cut by as much as 90 per cent. upon the adoption of the all-weather approach light system.

QUESTIONS AND ANSWERS

(Continued from page 22.)

The accompanying diagram shows the necessary data for applying an EF8. This valve has a side-contact base, but there is a companion type, the EF38, which has a standard octal base.

The EF8 is designed so that its screen, g_3, requires the full 250v. supplied to it. This eliminates the need for a screen dropping resistor or voltage divider. However, the normal screen bypass condenser should not be omitted.

The circuit given here does not show A.V.C. applied to the valve. Since the EF8 has a variable mu characteristic, A.V.C. may be applied as with any other tube. A 0.1 mfd. blocking condenser is inserted between the low potential end of the grid coil and earth, and the A.V.C. is fed to this end of the coil through a 100k. decoupling resistor.

If the EF8 is used to replace the first 6AC7 in a circuit such as the preamplifier described in a recent issue of "Radio and Electronics" it should not be necessary to control the gain, since the tube has a much lower mutual conductance than the 6AC7, and is not so easily overloaded. However, if a very strong local signal makes gain control advisable, the best plan is to use a 10k. wire-wound potentiometer in series with the 300-ohm cathode resistor, and connect as a rheostat.

THE ALL-WAVE EIGHT

(Continued from page 19.)

of at least a 10 in. speaker, but preferably a 12 in., and certainly either a console cabinet or a vented baffle. The latter can be designed from the chart which appeared in the December, 1946, issue of "Radio and Electronics," and made of such a shape as to fit into a console cabinet. This is the best possible answer to the cabinet problem, but excellent results will be obtained by using a console cabinet itself as the baffle, in the usual way.

Of course, there is no objection to installing the set, with an 8 in. speaker, in a larger than usual table type of cabinet, for the reproduction will still be good, but a larger baffle than is provided by this type of cabinet is definitely desirable if absolutely the best possible is to be obtained from the set.

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NOTE.—Your attention is drawn to the necessity of complying with the provisions of the Post and Telegraph Act regarding transmitting apparatus.

BEGINNERS' COURSE

(Continued from page 34.)

circuits. For example, if the circuit of Fig. 27 does not give enough selectivity, the circuit of Fig. 7 ("Radio and Electronics," December, 1946, p. 42) can be used in conjunction with the triode detector circuit of Fig. 27.

In order to combine the two circuits, we take Fig. 27 and delete everything to the left of C_2 and R_1. We now take Fig. 7 and remove the crystal and headphones and attach the joining point of C_2 and R_1 to the wire which formerly went to the crystal in Fig. 7. Of course, the A—B—connection on Fig. 27 must also be connected to the earthed end of the tuned circuit on Fig. 7.

In a similar way the triode detector may be added to any of the tuning circuits we have given for crystal sets.

The circuit of Fig. 27 will give a good deal more sensitivity than a crystal set, and should make an excellent headphone set for local stations only. From this circuit it is a very short step to a single-valve set using a triode detector that is able to receive broadcast stations at very long ranges—from Australia, for example.

(To be continued.)

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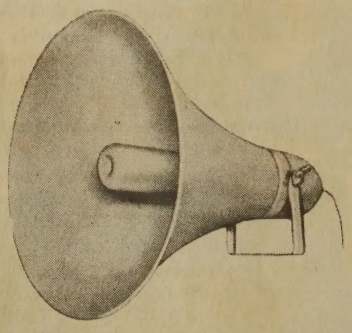

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